A SYSTEMATIC REVISION OF THE FISHES OF THE TELEOST FAMILY CARAPIDAE (PERCOMORPHI, BLENNIOIDEA), WITH DESCRIPTIONS OF TWO NEW SPECIES

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A SYSTEMATIC REVISION OF THE FISHES OF THE TELEOST FAMILY CARAPIDAE (PERCOMORPHI, BLENNIOIDEA), WITH DESCRIPTIONS OF TWO NEW SPECIES

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SYNOPSIS

The life history, mode of life and behaviour of *Carapus acus* (Brünnich) are briefly reviewed and compared with those of other species. An account of the range of skeletal structure within the Carapidae is given as a basis for generic separation, the various species are redescribed and their synonymies are revised. Two new species of the genus *Carapus* are described. Keys are given for the diagnosis of the genera, subgenera and species recognized. The paper is illustrated by 20 text-figures and includes a list of the principal references to the family Carapidae.

CONTENTS

I. INTRODUCTION

The best known member of the Carapidae is the Mediterranean species *Carapus acus* (Brünnich), a monograph on which was published over seventy years ago (Emery, 1880). This account was principally devoted to the adult anatomy, but also included observations on the life history and behaviour of the fish. Other members of the family have been briefly recorded in a number of ichthyological works, but no general account of the family appears ever to have been published.

The work here recorded was performed mainly in Italy and at Plymouth. Studies on living fish were undertaken during tenure of the Oxford and Royal Society Tables at the Stazione Zoologica, Naples, while the taxonomic portion of the work was performed almost entirely during tenure of the Oxford Table at the Laboratory of the Marine Biological Association of the United Kingdom, Plymouth. Short periods were also spent in study at the British Museum (Natural History) and at the Scottish Home Office Laboratory, Aberdeen.

Preserved specimens were obtained from certain other sources, notably from the following institutes :

Universitetets Zoologiske Museum, Copenhagen.
Institut Océanographique, Monaco.
Museu Municipal, Funchal, Madeira.
Institut za Oceanografiju i Ribarstvo, Split.

Information on the distribution of various species was obtained by correspondence with the following laboratories :

Institut d'Hydrobiologie et de Pêche, Alexandria, Egypt.
Marine Biological Station, al Gardaqa, Egypt.
Institut Scientifique Chérifien, Rabat, Morocco.
Laboratorio Oceanográfico, Malaga, Spain.
Station Biologique, Roscoff, France,
Station Biologique, Archachon, France.
Institut za Biologiju Mora, Rovinj, Yugoslavia.
Zoology Department, University College, Achimota, Gold Coast.
East African Marine Fisheries Research Organization, Zanzibar.
The University, Travancore, India.
Fisheries Department, Penang, Malaya.
Department of Agriculture, Sandakan, North Borneo.
Department of Harbours and Marine, Brisbane, Australia.
Department of Zoology, The University, Sydney, Australia.
Victoria University College, Wellington, New Zealand.
Department of Zoology, The Museum, Dunedin, New Zealand.

Radiographs of representative specimens were made by the Radiography Department of the Royal Naval Hospital, Devonport, and of type material by Mr. A. C. Wheeler of the British Museum (Natural History).

My most grateful thanks are due to the Directors and Staffs of these various institutions, without whose kindly co-operation and assistance this work would not have been possible and to the many individual workers with whom I have discussed the results of this investigation and the problems arising therefrom.

During the course of this study financial support was provided by the Oxford Naples Scholarship and by a maintenance grant and supplementary grants from the Department of Scientific and Industrial Research.

II. THE LIFE HISTORY OF *CARAPUS ACUS*

Eggs attributable to *C. acus* are found in the Mediterranean during July, August, and early September, floating at the sea surface in yellowish, oval masses each containing some thousands of eggs. The egg is ellipsoidal, with diameters of 0·90 mm. and 0·75 mm., and has a large oil-globule, the yellowish tint of which is responsible for the colour of the egg-rafts (Raffaele, 1888). Spawning has not been

observed, not has artificial fertilization been achieved. Embryonic development is rapid, the larva hatching in an anatomically incomplete condition on the third day after spawning. Emery described the early development in general terms, but owing to the paucity of material the embryology of the fierasfers has never been subjected to critical study by modern methods.

At hatching, the young fish enters the first larval stage, the vexillifer, characterized by a long dorsal appendage, the vexillum. On the first day of post-embryonic life this appendage is a small, pigmented thickening at the anterior end of the dorsal fin, but as the larva grows the thickening enlarges, forming first a small papilla, then a soft, forked projection and finally a long, lobed structure whose size and complexity increase with the increasing size of the larva (Emery, 1880). As the vexillum grows, its pigment is limited first to the lobes and then to their proximal portions, leaving the stalk and distal parts of the lobes relatively unpigmented in the older larvae. Later still the vexillum degenerates and the larva sinks from the surface into the deeper layers until finally, with the appendage reduced to a mere projection or even lost entirely, the young fish enters upon the benthic mode of life of the second carapid larva. It is probable that regression does not often run its full course, for the fragility of the vexillum is such that few fish are obtained with it undamaged and it must often be broken off instead of resorbed.

Emery hatched fierasfer larvae in the aquarium and reared them for about a week, but was unable to feed the fish and could not follow their development after they had attained a length of 3–4 mm. Further knowledge of the growth and metamorphosis of the vexillifer has been obtained solely from specimens taken in plankton hauls, most of which were never studied alive. The youngest vexillifers taken in the plankton were a pair obtained by Emery. They were about 10 mm. long, but showed little advance on those he was able to rear. Others studied by Padoa (1947) ranged from 15 mm. to 85 mm. in length. From this author's account it appears that increase in size is unaccompanied by any great changes in proportion. The head remains approximately one-fifteenth of the total length, the preanal length about one-tenth of the total, while throughout the vexillifer stage the end of the abdominal cavity is only a short distance behind the anus. A 76 mm. vexillifer mentioned by Emery agrees well with Padoa's series, as do the large specimens described by Gasco (1870) and Costa (1871) under the name *Vexillifer dephilippii* Gasco.

The second larval stage of *C. acus* is at first benthic, later inquiline. It was originally described as *Encheliophis tenuis* Putnam (1874) and Padoa (1947) has proposed that it be termed the tenuis larva. The tenuis has been found far less frequently than has the vexillifer and records of perhaps not more than 20 have appeared in the literature.

The tenuis stage is essentially a phase of growth and change. It lacks the vexillum and is characterized principally by the immense length of the cylindrical body and the relative smallness of the head. In the later vexillifers the head comprises about one-fifteenth of the total length, yet in the youngest tenuis so far described (Emery, 1880) the head constituted but one-thirtieth of the total and its actual length, 5 mm., was no greater than that of the head of a vexillifer of only half its size.

While the tail is elongating, the head and trunk of the tenuis are also growing,

though not nearly so rapidly. Thus the disparity between head and trunk length on the one hand and total length on the other continually increases. At a total length of about 200 mm. further changes occur. Elongation is now replaced by shortening ; tail growth by tail resorption. But though the tail region of the tenuis now decreases in length, the head and trunk regions continue to grow and the proportions of the body approach ever more closely to those of the adult fish. However, even in the anterior region of the body not all parts develop alike, for while the head and abdominal cavity elongate, the anus remains at about the same distance from the snout and thus occupies an ever more advanced position. During this and subsequent stages of development the depth of the body also increases, though the width remains fairly constant, and the cylindrical body of the tenuis is converted to the compressed form of the adult fierasfer.

The tenuis lacks pigment except for the silvery iris and black and red chromatophores on the top of the head. Trunk and tail are glassily transparent. When removed from a holothurian, the tenuis has a pinkish tinge which fades after a short time in sea water and is never recovered. It is apparently due to the colour of the blood.

The tenuis does not metamorphose directly into the adult, but into a well-marked juvenile stage (Arnold, 1953). This is primarily a period of consolidation in which the developmental trends of the tenuis are continued to produce the adult form. At the close of metamorphosis the head of the young fish is about one-twelfth of the total length ; the anus is beneath, or only a little behind, the vertical through the roots of the pectoral fins ; the pectorals are round and short, one-quarter to one-third the length of the head ; and patches of black pigment have begun to appear on the still translucent tail.

At first the total length, 70–80 mm., alters but little, though the head continues to elongate and the trunk to deepen. When the adult proportions have been nearly obtained and the length of the head is between one-seventh and one-eighth of the total length, the fish elongates once more. Now, however, all parts of the body grow at about the same rate and there is little further alteration in proportions, beyond a deepening of the anterior part of the trunk and the advancement of the anus to a position a little in front of the pectoral fins. The changes in length of head relative to total length during the life history of *C. acus* are shown graphically in Text-fig. 1. As growth proceeds, the pectorals elongate, becoming oval and about one-half the length of the head, while red chromatophores appear among the black. The reddish tinge given to the body marks the end of the juvenile stage and may perhaps be associated with the onset of sexual maturity. Behavioural changes also occur at this time.

The dentition of the developing *C. acus*, owing to the importance of dental characters in the identification of adult fierasfers, deserves special consideration. The smallest vexillifers lack teeth, but in later individuals teeth appear on jaws, palatines and vomer. These teeth are at first uniserial in arrangement and of uniform size, but as the vexillifer grows a pair of rather larger teeth appears at the front of the upper jaw, followed by a similar pair in the lower jaw, and both pairs are fully developed by the time that a total length of 60 mm. has been attained (Padoa,

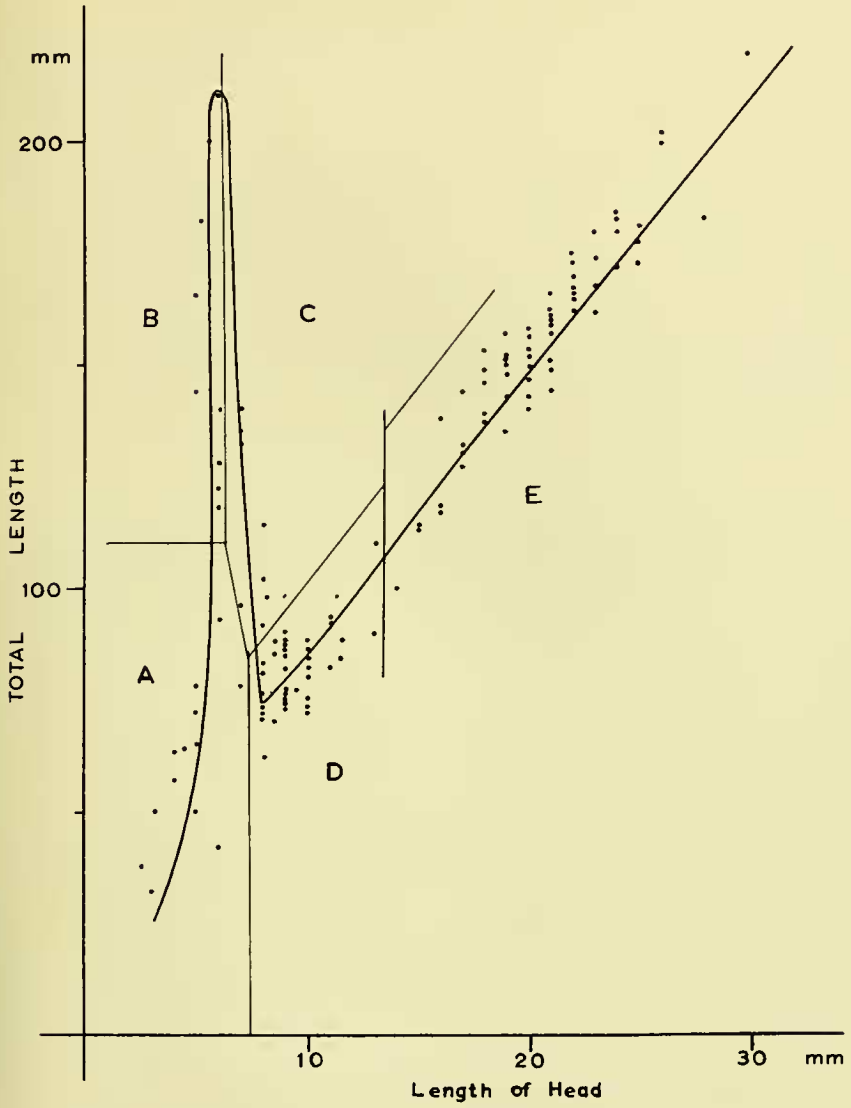

FIG. 1.—Changes in proportions (head length relative to total length) during the life history of *Carapus acus*. A, Vexillifer; B, early tenuis; C, late tenuis; D, juvenile; and E, adult stages.

1947). Towards the end of the vexillifer stage the size difference between these anterior teeth and those in the rest of the jaw diminishes and towards the close of the tenuis stage enlarged anterior teeth are no longer present. Throughout the tenuis period the dentition remains uniserial on jaws and palatines, but at the beginning of the juvenile stage the number of rows begins to increase until the completely polyserial condition of the adult is attained.

It has been suggested (Dean, 1895) that the elongated bodies of the fierasfers, their persistent notochord and functional pronephros are expressions of a general paedomorphic tendency of the family and it is probable that the dental characters of many species, the enlarged anterior jaw teeth of certain *Carapus* spp. and the uniserial dentition of *Encheliophis*, are also larval characters perpetuated in the adult form. In the circumstances, considerable doubt is cast upon the validity of the dentition as a diagnostic character for the separation of new species unless it can clearly be shown that the types are mature individuals, while the occurrence of partially uniserial dentition in a fierasfer of small size can probably always be taken as indicating that the specimen in question is in the juvenile stage of its development.

III. BEHAVIOUR AND MODE OF LIFE

The behaviour of the adults of *Carapus acus* was first studied by Emery (1880), who found that the fish swam in a sharply-tilted, head-down position and entered the host holothurian tail-first through the anus. Recent observations on the same species (Arnold, 1953) have shown pronounced behavioural differences between fish in different stages of the life history. The youngest specimens of *C. acus* studied alive were tenuis larvae obtained from *Holothuria tubulosa*. When removed from the host and placed in sea water they showed a characteristically violent movement. The body was slanted upwards, the head even thrust above the surface of the water, and its flexures were of extremely wide amplitude, very different in appearance from the normal swimming movements. Such " tenuis " movements were occasionally shown by juveniles and adults when removed from their hosts or when attempting to evade capture. Fish displaying " tenuis " movements did not respond in any way to the presence of a holothurian, nor did the tenuis larvae themselves appear to be capable of entering a new host. Juveniles and adults, however, responded at once to the presence of a holothurian and would swim the length of its body until they located the anus, then attempt to enter. Adults almost always entered tail-first by means of a pronounced corkscrew motion in which the body of the fish rotated through 360° or more. The juveniles normally entered head-first, though some of the older specimens might make incomplete and unsuccessful attempts at a tail-first entry. Only those fish which had attained their full growth in the juvenile condition and were beginning to assume the form and colour of the adult displayed both modes of entry.

Behaviour differences such as these may be shown also by other fierasfers, but at present the few recorded observations on other members of the Carapidae relate almost entirely to adult fish. Tail-first entry has been described for the adults of *C. bermudensis* (Jones) (Linton, 1907; Aronson & Mosher, 1951) and *C. homei*

(Richardson) (Mukerji, 1937). The entry of *Encheliophis gracilis* (Bleeker) into starfish has been observed (Doleschall, 1861), but it is not clear from this account whether entry was head-first or tail-first. *Encheliophis hancocki* (Reid) has been observed both to enter and leave its host head-first (Steinbeck & Ricketts, 1941). Nothing whatsoever is known of the behaviour of those species which inhabit lamellibranchs.

Most accounts of the behaviour of fierasfers have been purely descriptive and little attempt has been made to analyse the behaviour of any species in terms of stimuli and responses. Studies on adults and juveniles of *C. acus* by means of various models showed that the fish responded only if the water contained mucus from a holothurian and provided that the model was long relative to its depth (Arnold, unpublished observations). In the absence of a chemical stimulus *C. acus* shows none of the exploratory movements that usually precede attempt at entry, while an ovoid or circular model is usually ignored. Presence of a water current seems to be a necessary prerequisite for actual penetration, though in the absence of prior chemical and visual stimuli a water current alone has either no effect or is actually repellent to the fish. Recent work on *C. bermudensis* has shown that in this species chemical and tactile stimuli are of most importance (Aronson & Mosher, 1951), but a full account of this work has yet to be published.

C. acus lies within the body cavity of its host, usually at the anterior end among the branches of the gonads, on which it apparently feeds. The tennis larva does not survive long after removal from its host and the fierasfer must thus remain within its first holothurian throughout this period of its life history. Juveniles and adults live well in sea water and small crustacea have been found among their stomach contents. It is probable that *C. acus* leaves its host only when the holothurian eviscerates.

Little is known of the location of other fierasfers within the bodies of their hosts. *Encheliophis gracilis* apparently breaks into the body cavity of the starfish it ininhabits (Doleschall, 1861 ; Yosii, 1928), and *Encheliophis vermicularis* Müller has been found within the body cavity of its host holothurian, feeding upon the viscera (Semper, 1861). Both *Encheliophis hancocki* and *C. bermudensis* have been observed freely to enter and leave their hosts (Steinbeck & Ricketts, 1941 ; Linton, 1907) and thus can hardly have penetrated further than the cloaca or base of the branchial trees. Different species of fierasfer doubtless differ in their dependence upon their hosts and in the distance to which they penetrate into the body.

Some fierasfers seem to show little host specificity. *C. homei,* for example, has been recorded from holothurians, asteroids, echinoids, lamellibranchs and a tunicate. Others however, are restricted to particular host species. Thus *C. bermudensis* has been recorded only in *Actinopyga agassizi, Encheliophis sagamianus* (Tanaka) only in *Holothuria monacaria,* and *C. acus* only in *H. tubulosa* and *Stichopus regalis.* In the laboratory *C. acus* also enters *H. poli, H. helleri* and *H. sanctori,* but does not respond to *Cucumaria planci* or *Phylloporus urna.* It does not penetrate into the body cavity of *H. poli,* but lodges in the branchial trees and usually emerges within 24 hours. Choice experiments did not provide evidence that *C. acus* could distinguish between *H. tubulosa* and *H. poli* prior to entry.

IV. STRUCTURE

A full account of the structure of the commonest European fierasfer, *Carapus acus*, was given by Emery (1880), but little is known of the anatomy of any other species. Owing to the general rarity of the fierasfers it has been impossible to make a comparative study of their soft anatomy, but X-ray examination of a number of the types and of other clearly identifiable specimens has enabled the skeletons of a number of species to be studied without damage to the specimens themselves. In all species examined the tail and posterior trunk vertebrae have been found to possess the same general characters, differing only in size and relative degree of ossification. The centra are characteristically hour-glass shaped, generally twice as long as wide or high, and surmounted by long, pointed, backwardly directed neural spines which in the trunk region project above the succeeding vertebrae, but in the tail region become progressively smaller until towards the tip of the tail they are no longer recognizable. The transverse processes of the trunk vertebrae jut out at right angles from the centra, then turn downward and backward. The haemal spines of the tail vertebrae are extremely long anteriorly, but decrease in height towards the tip of the tail. In this region ossification becomes so slight that it is usually impossible to count the total number of vertebrae, the most posterior of which are mere rings encircling the persistent notochord.

But though the various species resemble each other in the form of the majority of their vertebrae, in the structure of the anterior vertebrae and of the lower jaw they are classifiable into three sharply separated groups, two of which may be further subdivided by means of other characters. In the systematic portion of this account, this subdivision of the Carapidae on the basis of skeletal characters has been used as the basis for generic separation of the adults. Though it has not been possible to examine the skeletal characters of larval fierasfers, the lower jaws (which can easily be seen by superficial examination) show similiar variations to the lower jaws of adults and thus provide grounds for generic classification even of immature specimens.

The majority of fierasfers examined—including representatives of the species originally described as *Gymnotus acus* Brünnich, *Fierasfer dubius* Putnam, *Lefroyia bermudensis* Jones, *Oxybeles Homei* Richardson, *Fierasfer parvipinnis* Kaup, *Fierasfer affinis* Günther, *Fierasfer caninus* Günther, *Fierasfer margaritiferae* Rendahl and *Carapus parvibrachium* Fowler—form a fairly homogenous group which in the main corresponds with the genus *Carapus* as at present understood. The majority of these species have 17–18 trunk vertebrae (19–20 in *Fierasfer margaritiferae* and *Carapus parvibrachium*), the first of which has a roughly cubical centrum surmounted by a stout neural spine with a truncated tip. This spine slopes forward and appears to be attached to the skull by a calcified ligament. The transverse processes of the first vertebra are slender and scimitar-shaped, directed backward and downward. The second vertebra resembles the first in the form of its centrum and transverse processes, but has a pointed neural spine which slopes slightly backward. The third and fourth vertebrae have hour-glass shaped centra, long backwardly-projecting neural spines and expanded transverse processes which are fused together into broad

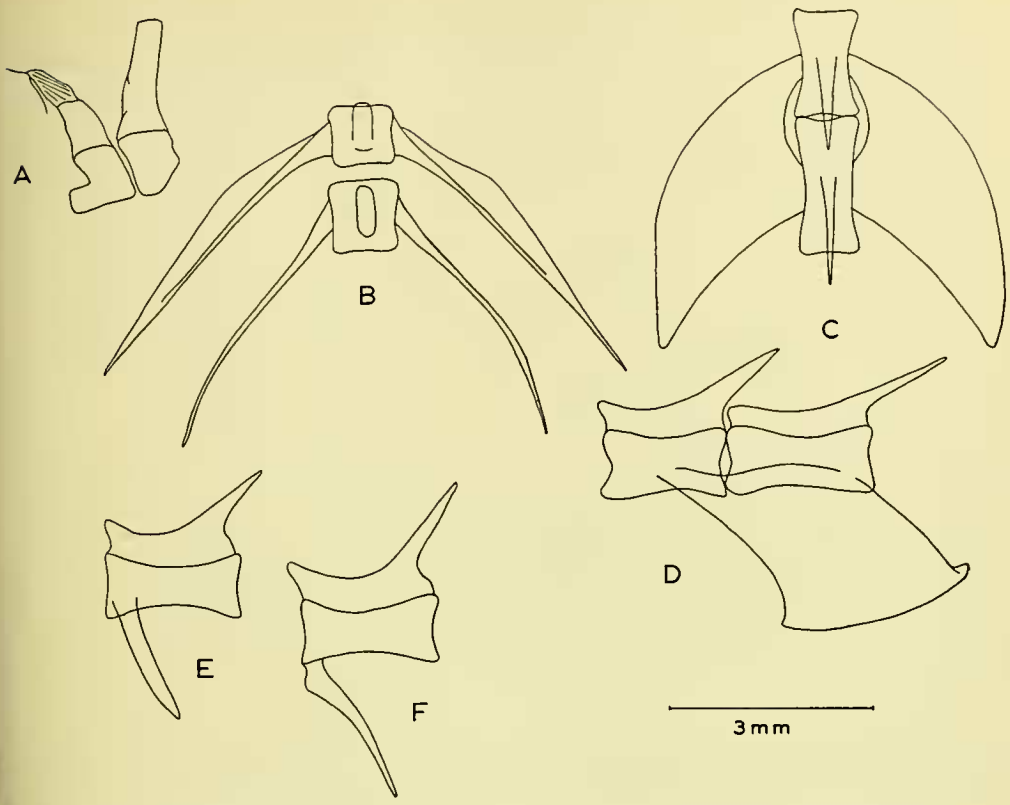

FIG. 2.—Vertebrae of *Carapus acus*. A, Nos. 1 and 2, lateral aspect (transverse processes omitted); B, nos. 1 and 2, dorsal aspect; C, nos. 3 and 4, dorsal aspect; D, nos. 3 and 4, lateral aspect; E, representative posterior trunk vertebra; F, representative anterior tail vertebra. (*Camera lucida* drawings from radiographs.)

flat plates, rounded anteriorly and tapering posteriorly to points level with the middle of the fifth vertebra (Text-fig. 2).

In this group of fierasfers the lower jaw is nearly flat along its lower edge. The upper tooth-bearing edge commences parallel to the lower, then curves upwards to the greatly expanded proximal portion of the jaw (Text-fig. 3A). The narrowest part of the jaw is the extreme tip, from which a lateral ridge, parallel to the lower edge, extends to the point of articulation with the cranium. Just beneath this ridge there is at the distal extremity of the jaw a deep and narrow notch. The teeth are in a narrow band (a single row only in the larvae) along the entire exposed surface of the jaw. Each tooth is separated from its neighbours by a space almost as wide as the diameter of the base of the teeth.

Two of the species included within this group, *Fierasfer margaritiferae* and *Carapus parvibrachium*, could not be examined in such detail as the rest owing to the presence of a large reniform, calcareous body lying in the midline in the anterior part of the body. This structure, presumably the anterior part of the swim-bladder, effectively concealed parts of the second, third and fourth vertebrae. So far as they could be seen, however, they appeared similar in general structure to those of of the other species, though undoubtedly differing in detail. These two species differ

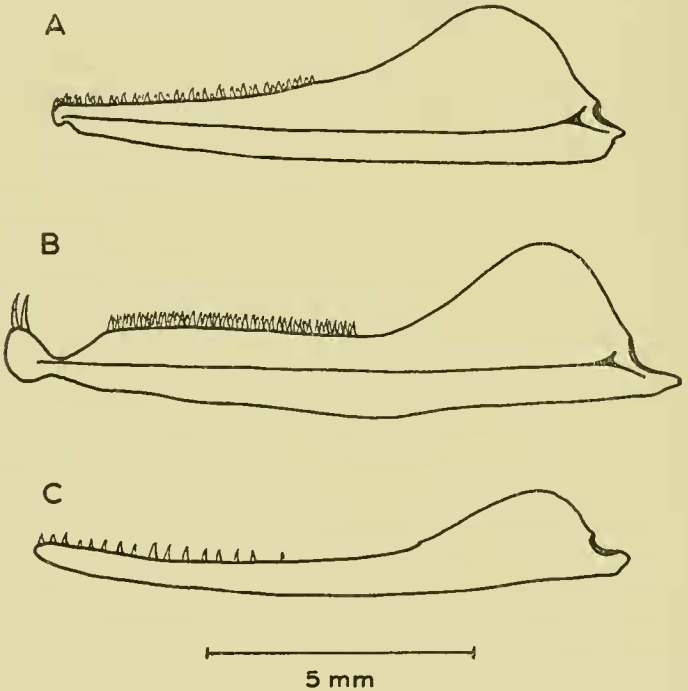

FIG. 3.—Jaw structure in the Carapidae. Lower jaws of A, *Carapus*; B, *Echiodon*; and and C, *Encheliophis*. (Semidiagrammatic drawings based upon radiographs.)

also from the others in their slightly greater number of trunk vertebrae and in certain aspects of their dentition. In the systematic account they are therefore accorded subgeneric status.

The second group of fierasfers contains only two species which have been available for examination, those originally described as *Ophidium dentatum* Cuvier and *Echiodon Drummondi* Thompson. These species have been frequently confused with each other and generally assigned to *Carapus*. Both in structure and appearance, however, they differ considerably from the group of species so far considered. The body is considerably longer and the trunk region of the vertebral column comprises 27–28 vertebrae, the first two of which are similar to the first two of the species

already considered. The third and fourth vertebrae, in contrast, are entirely separate from each other and show not the least sign of fusion of the transverse processes (Text-fig. 4). The edges of the lower jaw are flat and parallel, the proximal portion is small and at its tip the jaw first narrows, then expands again as a small knob (Text-fig. 3B). A lateral ridge runs from this knob, across the narrowed portion of the jaw and as far as the articulation with the skull. The dentition comprises two series. Anteriorly one or two immense, fang-like teeth occupy the terminal knob, while the neck is toothless and its position easily visible in the intact animal as a pronounced diastema. The rest of the jaw is occupied by a narrow band of teeth (or single row only in the larva) closely pressed together.

Composing the third group of fierasfers is a number of species which, judged externally, appear to fall into two classes. Examples of the species originally

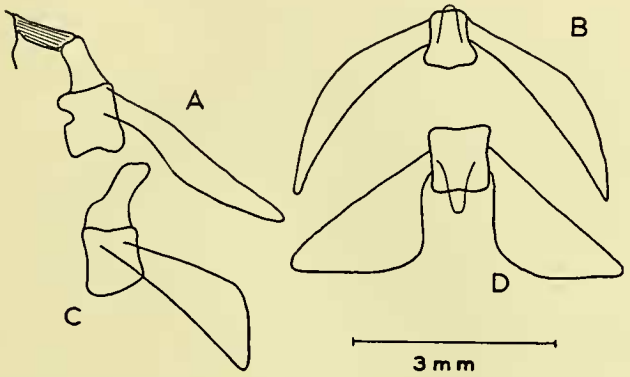

FIG. 4.—Vertebrae of *Echiodon drummondi*. A, No. 1, lateral aspect; B, no. 1, dorsal aspect; C, no. 2, lateral aspect; and D, no. 2, dorsal aspect. (*Camera lucida* drawings from radiographs.)

described as *Oxybeles gracilis* Bleeker and *Encheliophis vermicularis* Müller have been studied. Of these, *E. vermicularis* lacks pectoral fins though the girdle is still present, while specimens of *O. gracilis* are individually more robust and possess small pectorals. In vertebral and jaw structure, however, *O. gracilis* and *E. vermicularis* are almost identical. There are 30–31 trunk vertebrae, the first two of which resemble those already described for the first group of fierasfers, with the exception that the neural spine of the second vertebra is rather shorter and stouter and is attached to the back of the skull by a structure which is apparently a slender, calcified ligament. The insertion of this ligament spreads on to the anterior part of the neural arch of the third vertebra (Text-fig. 5). It is characteristic of this third group of fierasfers that the third, fourth and fifth trunk vertebrae have their transverse processes expanded and fused into wide lateral wings, the outer edges of which are smoothly curved, while their points reach as far back as the level of articulation between the sixth and seventh vertebrae.

O. gracilis and *E. vermicularis* differ from all other fierasfers in the slender, curved form of the lower jaw. The narrowest portion is at the tip, the proximal part is little expanded and the lateral ridge is little developed (Text-fig. 3c). Even in the adult the teeth are in a single row only and are widely separated from each other, the

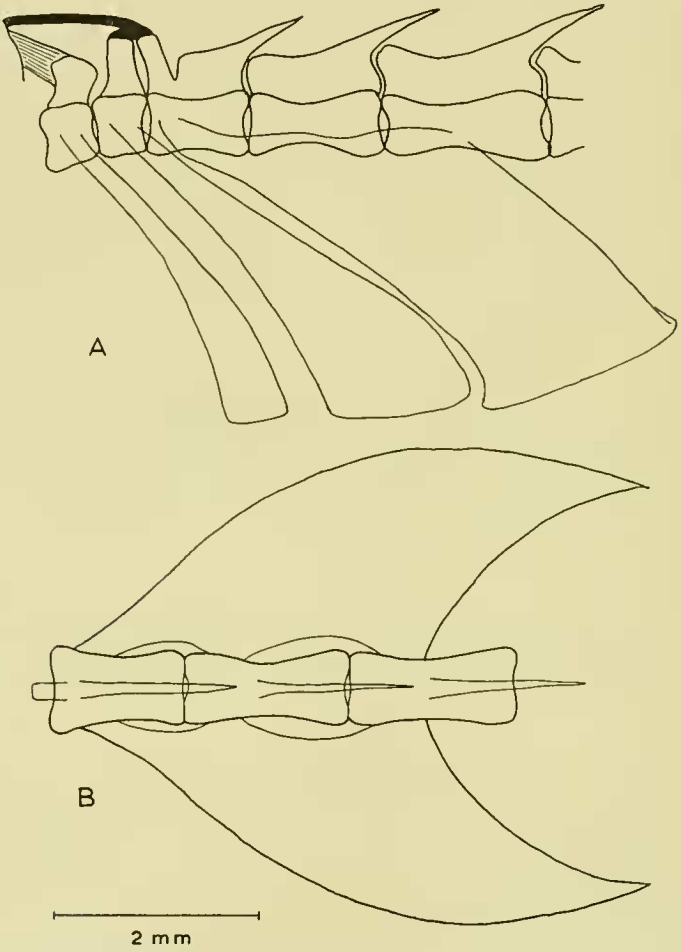

FIG. 5.—Vertebrae of *Encheliophis* (*Jordanicus*) *gracilis*. A, Nos. 1–5, lateral aspect; B, nos. 3–5, dorsal aspect. (*Camera lucida* drawings from radiographs.)

distance between successive teeth being as much as two or three times the diameter of the tooth-base.

Various characters have been used for the discrimination of species within the Carapidae, but those which have proved most generally useful for diagnosis are the

dentition and certain proportions of the body. Owing to their soft bodies, fierasfers are liable to shrinkage and distortion on preservation and in the following systematic description all measurements have been made on specimens preserved either in formalin or, more usually, in alcohol. In order to determine the effect of post-mortem shrinkage and to enable these measurements to be related to the dimensions of the living fish, a number of specimens of *C. acus* were measured immediately after being killed in 25% alcohol and again after eighteen months preservation in 70% alcohol. The total length was found to decrease by about 6%, the length of the head by about 1% and its depth by about 2%.

V. SYSTEMATIC ARRANGEMENT

Family Carapidae

(Fierasferidae of older literature and originally united with the Ophidiidae, commonly known as fierasfers, pearl-fish or glass-eels).

Familial characters. Small percomorph fishes with slender, elongate, compressed or cylindrical, scaleless bodies, tapering to an acuminate tail; head short, usually thickest and deepest part of body; snout blunt and rounded; eye large, slightly oval, placed high on side of head; posterior nostril a crescentic slit just in front of the orbit; anterior nostril circular, on small papilla at about midlength of snout; mouth large, usually oblique, lower jaw included within upper; maxilla reaching to or beyond posterior margin of orbit; teeth on premaxillae, dentaries, palatines and vomer, those of upper jaw being the smallest and those of the vomer usually the largest; tongue smooth, pointed, free at tip; gill-openings wide, the four membranes little united and leaving most of the isthmus uncovered; branchiostegals 6 or 7; top posterior margin of operculum prolonged as small point projecting back above base of pectoral fins; anus far forward in adult; median fins long and low, inserted just behind head and continuous round tip of tail; no caudal fin; no pelvic fin or girdle; pectoral girdle always present, but pectoral fin may be reduced or even absent; sexes not distinguishable on external characters; eggs pelagic; life history complex, probably always involving a planktonic larva (vexillifer) and a benthic larva (tenuis).

Key to Genera and Subgenera—Adults only

1	Teeth in bands on jaws and palatines; maxilla not concealed by skin	2
	Teeth in single rows on jaws and palatines; maxilla concealed by skin	3
2 (1)	No diastema in lower jaw; anus almost vertically below base of pectoral	4
	Diastema in lower jaw; anus clearly posterior to base of pectoral	*Echiodon*
3 (1)	Pectoral fins present	*Encheliophis* (*Jordanicus*)
	Pectoral fins absent	*Encheliophis* (*Encheliophis*)
4 (2)	Anterior teeth not fang-like, body slightly compressed or cylindrical, deepest part usually the head	*Carapus* (*Carapus*)
	Anterior pair of teeth in each jaw large, fang-like; body strongly compressed, deepest part behind head	*Carapus* (*Onuxodon*)

Genus *CARAPUS* Refinesque 1810

Type *Gymnotus acus* Linnaeus

Carapus Rafinesque-Schmaltz, 1810, *Indice d'Ittiologia Siciliana* : 57. No type stated ; *Gymnotus acus* Linnaeus was designated type by Opinion 42 of the International Commission for Zoological Nomenclature, 1912.

Fierasfer Oken, 1817, *Isis*, 1817 : 1182. Name derived from " les fierasfers ", Cuvier 1815, *Mém. Mus. Hist. nat. Paris*, **1** : 119. Type *Ophidium imberbe* Cuvier, 1815, (non *Ophidion imberbis* Linnaeus, 1758, *Systema Naturae*, **1** : 259).

Diaphasia Lowe, 1843, *Proc. zool. Soc., Lond.* **11** : 92. Type *Gymnotus acus* Brünnich, 1768, *Ichthyologia Massiliensis* : 13.

Oxybeles Richardson, 1844, *Ichthyology of the Voyage of H.M.S. " Erebus " and " Terror "* : 73. Type *Oxybeles Homei* Richardson, 1844.

Porobronchus Kaup, 1860, *Ann. Mag. nat. Hist.* (3) **6** : 272. Type *Porobronchus linearis* Kaup, 1860.

Helminthodes Gill, 1864, *Proc. Acad. nat. Sci. Philadelphia*, **16** : 203 (non *Helminthodes* Marsh, 1864, *Amer. J. Sci.* **38** : 415). Type *Oxybelus lumbricoides* Bleeker, 1854, *Nat. Tijdschr. Ned.-Ind.* **7** : 163.

Vexillifer Gasco, 1870, *Bull. Assoc. Nat. Med. Napoli*, **1870** : 59. Type *Vexillifer dephilippii* Gasco, 1870.

Helminthostoma Cocco. MS name cited by Günther, 1870, *Catalogue of Fishes*, 8 : 145. Type *Helminthostoma delle Chiaje* Cocco.

Lefroyia Jones (J. M.), 1874, *Zoologist*, (2) **9** : 3837. Type *Lefroyia bermudensis* Jones, 1874.

Rhizoiketicus Vaillant, 1893, *C.R. Acad. Sci., Paris*, **117** : 745. Type *Rhizoiketicus carolinensis* Vaillant, 1893.

Leptofierasfer Meek & Hildebrand, 1928, *Publ. Field Mus. zool. Ser.* **15** : 963. Type *Leptofierasfer macrurus* Meek & Hildebrand, 1928.

Pirellinus Whitley, 1928, *Rec. Austral. Mus.* **16** : 211. Type *Oxybeles lumbricoides* Bleeker, 1854.

Disparichthys Herre, 1935, *Publ. Field Mus. zool. Ser.* **18** : 383. Type *Disparichthys fluviatilis* Herre, 1935.

GENERIC CHARACTERS. Body compressed or cylindrical ; lateral processes of first and second vertebrae long and not expanded, of third and fourth vertebrae expanded and fused together, of fifth and subsequent vertebrae short and not expanded ; trunk vertebrae number 17–20 ; lower jaw stout, nearly straight, tooth-bearing portion tapering to tip ; in adult, teeth of jaws and palatines arranged in bands ; distance between teeth approximately equal to diameter of tooth-base ; no diastema in lower jaw ; maxilla extending beyond posterior edge of orbit in adult, clearly outlined by folds of skin ; interorbital domed ; upper edge of orbit not impinging on dorsal profile of head ; anus in adult close to roots of pectoral fins ; swim-bladder short ; no pyloric caecae ; branchiostegals 7.

The most familiar name for members of the Carapidae is " fierasfer ", a term first used by Brünnich (1768) who gave it as a local name for the species now known as *Carapus acus* in use by the fishermen of Marseilles. The name next appears as " les fierasfers " (Cuvier, 1815 and 1817) when it was used for a group of subgeneric rank under *Ophidium*, containing *Ophidium imberbe* (a synonym of *Carapus acus*) and *Ophidium dentatum* (now *Echiodon dentatus*). This was quickly given nomenclatural status as *Fierasfer* Oken (1817), the name which has been and is still the most widely used for members of this family.

However prior to Cuvier, the heterogenous Linnean genus *Gymnotus* had been divided into *Gymnotus, sensu strictu*, and *Carapus* by Rafinesque-Schmaltz (1810). Rafinesque did not specify a type for the new genus, nor even list the species it was created to contain, but gave only the following diagnosis :—

> " XII. Nessun'ala dorsale, ne caudale, un'ala anale e due pettorali, mascella superiore più lunga dall'inferiore, coda nuda al disotto. *Osserv.* Differisce dal vero genere *Gymnotus*, che ha l'ala anale lunghissima, ricuoprendo il disotto della coda, e la mascella inferiore più lunga dalla superiore." (XII. Neither dorsal nor caudal fins ; an anal fin and two pectorals ; upper jaw longer than the lower ; tail naked below. *Notes.* It differs from the true genus *Gymnotus*, which has the anal fin very long, covering the lower part of the tail, and the lower jaw longer than the upper.)

In another part of his account, Rafinesque cited *Gymnotus acus* Linnaeus as a Sicilian representative of *Carapus*. By Opinion 42, rendered 1912, the International Commission for Zoological Nomenclature has designated *Gymnotus acus* Linnaeus (no date given) as type of *Carapus* Rafinesque, invalidating *Fierasfer* as a generic name.

Gymnotus acus Linnaeus does not, strictly, exist at all and the characters used by Rafinesque in his diagnosis of *Carapus* are such as to exclude from this genus all species of fierasfer. Rafinesque derived his nomenclature from the 13th edition of the *Systema Naturae*, edited by Gmelin (1788), in which is a shortened description of *Gymnotus acus* Brünnich, correctly attributed, the species that Rafinesque presumably intended to name. The diagnosis of *Carapus* is apparently a translation into Italian of Gmelin's Latin description of the South American fresh-water fish *Gymnotus carapo* Linnaeus, type species of the genus *Gymnotus* Linnaeus. The resemblance of the new generic name to the older trivial name emphasizes the similarity of the descriptions.

Of the remaining generic synonyms, *Diaphasia* Lowe was proposed as an alternative to the then current name *Fierasfer*. The species described by Richardson and Jones are so closely akin to *Carapus acus* that generic separation of either is unwarranted, while *Rhizoiketicus* Vaillant must be united with *Carapus* for lack of distinguishing characters. This genus was created to contain a fierasfer from the Caroline Islands, the two examples of which were described as having large, easily-detachable, lozenge-shaped scales above and below the lateral line. These were not true scales, but were formed from and continuous with the outer cornified layers of the skin. Desiccation of any long-preserved fierasfer will cause cracking and flaking of the skin and these " scales " are thus no adequate reason for retaining *Rhizoiketicus* as a separate genus. The other characters of the two specimens are not recorded and they seem to be no longer in existence, nor has the species been found since. The other generic synonyms are based upon larvae. *Porobronchus* Kaup and *Vexillifer* Gasco belong to *C. acus*, *Helminthodes* Gill, and its substitute *Pirellinus* Whitley, probably to *C. homei*, and *Leptofierasfer* Meek & Hildebrand probably to *C. dubius* ; it seems likely that *Disparichthys* Herre may ultimately also be found to be attributable to a species of *Carapus*.

Recently, *Carapus parvibrachium* Fowler has been made the type of a new genus,

Onuxodon Smith, 1955, on the grounds that it differs from all other fierasfers in possessing an extremely deep, strongly compressed body, strongly domed interorbital and fewer vertebrae. To these characters may be added a partly calcified swim-bladder and a slightly greater number of trunk vertebrae than occurs in most species of *Carapus*. In all these features the species originally described as *Fierasfer margaritiferae* Rendahl agrees with *C. parvibrachium* and there can be no doubt that the two are congeneric. However, in other respects—vertebral and jaw structure, position of the anus, dentition, general body proportions—these two species are more closely akin to *Carapus* spp. than to the other fierasfers and for this reason it is considered that their probable evolutionary relationships are more truly expressed by regarding *C. parvibrachium* and *F. margaritiferae* as representing a subgenus of *Carapus*. In the following account, therefore, the genus is divided into two subgenera, *Carapus* and *Onuxodon*. It is not improbable that future investigations will result in the creation of a third subgenus to contain *Carapus parvipinnis* (Kaup), but this course is not at present justified.

Subgenus *CARAPUS*

SUBGENERIC CHARACTERS. Body slightly compressed or cylindrical, not so deep as length of head; interorbital flat or only slightly domed, its width equal to or greater than horizontal diameter of eye; trunk vertebrae 17–18; swim-bladder uncalcified.

KEY TO SPECIES—ADULTS ONLY

1	Head more than one-ninth of total length; pectoral fins more than one-third length of head	2
	Head less than one-ninth of total length; pectoral fins less than one-third length of head	*C. parvipinnis* *C. boraborensis*
2 (1)	No enlarged teeth at front of jaws	6
	Enlarged teeth at front of upper jaw	3
	Enlarged teeth at front of upper and lower jaws	9
3 (2)	Median row of large teeth on vomer, flanked by small teeth	4
	Anterior vomerine teeth small; posterior vomerine teeth large	*C. birpex*
4 (3)	Teeth of upper jaw uniserial	*C. pindae*
	Teeth of upper jaw polyserial	5
5 (4)	Outermost series of teeth in lower jaw considerably larger than inner series	*C. homei*
	Outermost series of teeth in lower jaw not conspicuously larger than inner series	*C. dubius* *C. bermudensis*
6 (2)	Maximum depth of body considerably greater than maximum depth of head	8
	Maximum depth of body not greater than maximum depth of head	7
7 (6)	Anus anterior to roots of pectoral fins	*C. acus*
	Anus vertically beneath roots of pectoral fins	*C. kagoshimanus*
8 (6)	Pectoral one-third length of head; body progressively tapering from region of maximum depth to tip of tail	*C. houlti*
	Pectoral more than one-half length of head; body narrowing sharply at end of abdomen before tapering to tail tip	*C. cuspis*
9 (2)	Head one-eighth to one-ninth of total length (about 200 mm.); outer series of teeth in lower jaw similar to inner series	*C. owasianus*
	Head one-sixth to one-seventh of total length (about 100 mm.); outer series of teeth in lower jaw much taller than inner series	*C. caninus*

Carapus acus (Brünnich), 1768

(Text-fig. 6)

Gymnotus acus Brünnich, 1768, *Ichthyologia Massiliensis* : 13. Artedi, 1788, *Bibliotheca Ichthyologica* : 164. Gmelin, 1788, *Systema Naturae Linnaei*, **1** : 1140.

Notopterus Fontanesii Risso, 1810, *Ichthyologie de Nice* : 82.

Ophidium imberbe Cuvier, 1815, *Mém. Mus. Hist. Nat., Paris*, **1** : 119. (non *Ophidion imberbis* Linnaeus, 1758, *Systema Naturae*, **1** : 259.) Cuvier, 1817, *Règne Animal*, **2** : 259.

Fierasfer imberbe, Oken, 1817, *Isis*, **1817** : 1182.

Ophidium fierasfer Risso, 1826, *Histoire Naturelle des Principales Productions de l'Europe Méridionale*, **3** : 212.

Fierasfer fontanesii, Costa (O.), 1829, *Fauna del Regno di Napoli*, **3** : tab. 20 bis.

Ophidium sp., Delle Chiaje, 1841, *Descrizione e Notomia degli Animali Invertebrati della Sicilia Citeriore*, **4** : 3.

Diaphasia acus, Lowe, 1843, *Proc. zool. Soc., Lond.* **11** : 92.

Fierasfer acus, Kaup, 1856, *Arch. Naturges.* **22** : 93. Kaup, 1856, *Catalogue of Apodal Fish* : 157. Günther, 1862, *Catalogue of Fishes*, **4** : 381. Steindachner, 1868, *S.B. Akad. Wiss. Wien*, **57** : 46. Canestrini, 1872, *Fauna d'Italia :* Pesci : 191. Emery, 1878, *Atti. Soc. ital. Sci. nat., Milano*, **21** : 37. Emery, 1880, *Fauna u. Flora Neapel*, **2** : 1. Giglioli, 1880, *Esposizione di Pesca* : 97. Perugia, 1881, *Elenco dei Pesci dell'Adriatica* : 38. Emery, 1882, *Mitt. zool. Stat. Neapel*, **3** : 281. Carus, 1885, *Prodromus Faunae Mediterranae*, **2** : 580. Raffaele, 1888, *Mitt. zool. Stat. Neapel*, **8** : 39. Lo Bianco, 1904, *Pelagische Tiefseefischerei der Maja in der Umbegung von Capri* : 24. Šoljan, 1948, *Ribe Jadrana* : 122.

Helminthostoma delle Chiaje Cocco. MS name cited by Günther, 1870, *Catalogue of Fishes*, **8** : 145.

Fierasfer massiliensis Brünnich. Name cited by Kaup, 1856, *Catalogue of Apodal Fish* : 157, without reference.

Porobronchus linearis Kaup, 1860, *Ann. Mag. nat. Hist.* (3) **6** : 272. Günther, 1870, *Catalogue of Fishes*, **9** : 145. Belotti, 1891, *Atti Soc. ital. Sic. nat., Milano*, **33** : 127.

Vexillifer dephilippii Gasco, 1870, *Bull. Assoc. Nat. Med., Napoli*, **1870** : 59.

Vexillifer de Filippii, Costa (A.), 1871, *Ann. Mus. zool., Napoli*, **6** : 88.

Encheliophis tenuis Putnam, 1874, *Proc. Boston Soc., nat. Hist.* **16** : 343.

Fierasfer dentatus (part), Emery, 1880, *Fauna u. Flora Neapel*, **2** : 16.

Fierasfer dentatus, Emery, 1882, *Mitt. zool. Stat. Neapel*, **3** : 283.

Fierasfer imberbis, Moreau, 1881, *Histoire Naturelle des Poissons de la France*, **3** : 226. Moreau, 1892, *Manuel d'Ichthyologie Française* : 405.

Carapus imberbis, Fowler, 1936, *Bull. Amer. Mus. nat. Hist.* **70** : 1073.

Carapus acus, Padoa, 1947, *Pubbl. Staz. zool. Napoli*, **20** : 111. Arnold, 1953, *Pubbl. Staz. zool. Napoli*, **24** : 153.

The material examined includes 39 specimens in the collection of the British Museum (Natural History) ; 17 in the collection of the Institut Océanographique de Monaco ; 22 in the collection of the Universitetets Zoologiske Museum, Copenhagen ; 40 in the Naples Sales Collection, 1952 ; and 29 in the Naples Sales Collection, 1954. Of these 147 specimens the majority were adults or juveniles, only a few being vexillifer or tenuis larvae. The localities represented were Sicily, Naples, Genoa, Monaco and Nice. The type, which was obtained at Marseilles, France, may be no longer in existence.

SPECIFIC CHARACTERS. *Adult* : Maximum length about 200 mm. ; length of head one-seventh to one-eighth of total length ; maximum depth of head one-half and maximum width one-third of length of head ; horizontal diameter of eye equal to length of snout and to interorbital width ; mouth very oblique ; maxilla extends

only a short distance posterior to orbit ; jaw teeth small and uniform ; vomerine teeth a little longer than jaw teeth, arranged in three slightly irregular, longitudinal rows, those of the central row being the largest ; pectoral fins one-half length of head ; anus anterior to roots of pectorals ; body slightly translucent in life, heavily blotched or barred with red ; about fifteen golden or silvery spots along flanks just above lateral line ; iris silver ; operculum and abdomen often with silvery lustre.

Juvenile : Adult colouration first assumed at about 100 mm. length ; general body form resembles that of adult, though head of younger individuals may be but one-ninth or one-tenth of total length ; dentition and proportions of head similar to those of adult ; maxilla extends little beyond hind edge of orbit ; pectorals one-third or less of length of head ; anus beneath or slightly anterior to roots of pectorals ; body translucent, spotted or barred with dark-brown or black ; no sign of red pigment whatsoever ; golden or silvery spots along sides as in adult.

Tenuis larva : Maximum recorded length more than 200 mm.; body slender and cylindrical, not compressed as in juvenile and adult ; head less than one-twelfth of total length ; maxilla extends only as far as middle of orbit ; teeth in single rows on jaws and palatines ; enlarged teeth may be present at front of one or both jaws ; pectoral fins less than one-fifth length of head ; anus posterior to roots of pectorals ; transparent and unpigmented in life.

Vexillifer larva : Maximum recorded length more than 80 mm.; head about one-tenth of total length ; maxilla extends only to anterior edge of orbit ; teeth in single rows on jaws and palatines ; older vexillifers have enlarged teeth at front of one or both jaws ; pectoral fins about one-eighth of length of head ; anus near posterior end of abdomen ; body translucent in life and devoid of pigmentation.

Eggs : Spawning period July-September ; eggs adhere in oval, yellowish rafts about 80 mm. in length.

The main dimensions of the adult fish studied are summarized in Table I and measurements and proportions of representative specimens are given in Table II.

TABLE I.—Carapus acus (*Brünnich*,) 1768. *Summary of Measurements and Proportions of Adults.*

Variate.	N.	R. mm.	M ± σ_M. mm.
Total length	72	100–202	155·4±2·34
Length of head	73	13–28	20·6±1·08
Depth of head	72	7–16	11·3±0·23
Width of head	49	4–11	8·0±0·25
Length of pectoral	49	7–16	10·6±0·30
Preanal length	49	13–23	18·7±0·37
		%	%
Length of head (% TL)	72	11·6–15·3	13·2±0·08
Depth of head (% HL)	72	43·8–71·4	55·0±0·69
Width of head (% HL)	53	26·7–50·0	38·6±0·23
Length of pectoral (% HL)	48	38·8–64·0	51·6±0·84
Preanal length (% TL)	47	10·8–13·3	11·6±0·10

N = number of specimens ; R = range of variate ; M = mean of variate (± standard error of mean, σ_M) ; TL = total length ; HL = length of head.

TABLE II.—Carapus acus (*Brünnich*), 1768. *Measurements and proportions of representative adults.*

Collection	British Museum	
Museum number	1952.11.25.1	1952.11.25.5
Locality	Naples	

	mm.		mm.	
Total length	184		152	
Length of head	24	(13% TL)	20	(13% TL)
Maximum depth of head	14	(58% HL)	11	(55% HL)
Maximum width of head	10	(42% HL)	9	(45% HL)
Length of snout	4	(17% HL)	3·5	(17·5% HL)
Horizontal diameter of eye	4	(17% HL)	3·5	(17·5% HL)
Verical diameter of eye	3·5	(15% HL)	3·2	(16% HL)
Interorbital width	4	(17% HL)	4	(20% HL)
Length of maxilla	11	(46% HL)	9·5	(47·5% HL)
Length of pectoral fin	12	(50% HL)	10	(50% HL)
Preanal length	22	(12% TL)	18	(12% TL)
Maximum depth of body	14·5	(60% HL)	13·5	(67·5% HL)

TL = total length; HL = length of head.

C. acus is quite common in the western Mediterranean, being recorded from the coastal waters of Spain, France, Italy, Sicily, Sardinia and the Balearic Islands. It may also occur in the Adriatic, Aegean and off the Algerian coast and has occasionally been reported in the Atlantic. These latter records, however, are of doubtful validity. *C. acus* has occasionally been taken free-swimming, but all stages except the vexillifer normally live within the body cavities of holothurians (*Holothuria tubulosa* and *Stichopus regalis*), where they attack the gonads and branchial trees. The tenuis larva is entirely dependent upon its host and does not survive long in sea water.

Carapus birpex n. sp.

(Text-fig. 7)

The type, the only specimen known, is an adult, found in a holothurian taken at Madeira, precise locality unknown. It is in the collection of the Museu Municipal, Funchal, Madeira, museum no. 2739. Two other fierasfers were found in the same holothurian, but it is unknown whether they have been preserved.

SPECIFIC CHARACTERS. Length of type 209 mm.; head one-seventh of total length; maximum depth of head more than three-fifths and maximum width one-fifth of length of head; horizontal diameter of eye equal to length of snout and slightly less than interorbital width; mouth very oblique; maxilla extends behind orbit for distance equal to half horizontal diameter of eye; owing to obliquity of mouth, end of maxilla almost cuts ventral profile of lower jaw; single pair of enlarged teeth at front of upper jaw, the rest, like those of the lower jaw, small and uniform; anterior half of vomer bears two slightly irregular rows of small, sharp, conical teeth, at either side of which the antero-lateral surfaces of vomer are smooth and toothless; posterior portion of vomer has a single median row of five, large, stout,

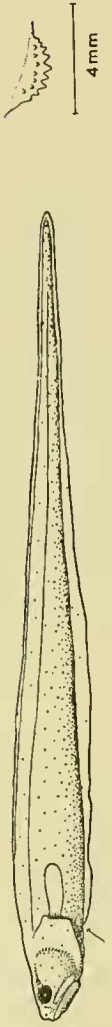

FIG. 6.—*Carapus acus* (Brünnich). A representative adult and its vomerine teeth.

FIG. 7.—*Carapus cuspis* n. sp. Type, and vomerine teeth.

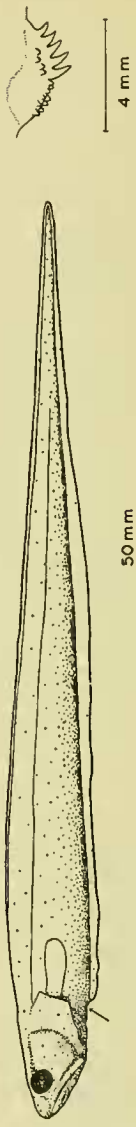

FIG. 8.—*Carapus birpex* n. sp. Type, and its vomerine teeth.

curved and sharply-pointed teeth, flanked by a number of smaller teeth similar to those on front of vomer; pectoral fins about two-fifths length of head; anus anterior to roots of pectorals; colour in life unknown. The other stages in the life history are unidentified.

The dimensions of the type are given in Table III.

TABLE III.—Carapus birpex *n. sp. Measurements and Proportions of the Type.*

Museum	Museu Municipal, Funchal.	
Locality	Madeira.	
	mm.	
Total length	209	
Length of head	29	(14% TL)
Maximum depth of head	15·5	(58% HL)
Maximum width of head	11	(39% HL)
Length of snout	5·5	(19% HL)
Horizontal diameter of eye	5·5	(19% HL)
Vertical diameter of eye	5	(17% HL)
Interorbital width	6	(21% HL)
Length of maxilla	15	(52% HL)
Length of pectoral fin	12	(41% HL)
Maximum depth of body	18	(62% HL)
Preanal length	25	(12% TL)

TL = total length; HL = length of head.

Carapus cuspis n. sp.

(Text-fig. 8)

The three known examples of this species were taken free-swimming near Madeira, position 33° 02′ N., 16° 20′ W., depth 100 metres (about 50 fathoms), during the 1897 cruise of the yacht " Princesse-Alice ". They were recorded, without description or figure, as *Fierasfer acus* by Roule (1917). The smallest of the three specimens is designated type and this and one paratype are in the collection of the Institut Océanographique de Monaco. A second paratype is in the collection of the British Museum (Natural History).

SPECIFIC CHARACTERS. Length of type 216 mm. (of paratypes 221 mm. and 230 mm.); head a little more than one-eighth of total length; maximum depth of head two-thirds and maximum width one-half of length of head; horizontal diameter of eye slightly greater than length of snout, but less than interorbital width; mouth oblique; maxilla extends behind orbit for distance equal to half horizontal diameter of eye; teeth on jaws and palatines resemble those of *C. acus*; vomer with single row of rather large, sharp, backwardly-directed teeth, flanked by a few smaller ones; anal fin deep, fleshy anteriorly; pectorals three-fifths length of head; anus slightly anterior to roots of pectoral fins. Colour in life unknown. Other stages in the life history have not been identified.

The body does not taper steadily from head to tail-tip, as in most fierasfers. Instead, the abdomen is deep and rounded and the maximum depth of the body is

about 40% greater than the maximum depth of the head. Beyond the abdomen the body narrows sharply to the long, tapering tail.

The paratypes closely resemble the type, differing only in their dimensions and in some minor details of their proportions. Through long preservation in alcohol their colour has been entirely destroyed, but a record from Algiers (Guichenot, 1850) may perhaps refer to this species. In this account a fierasfer, said to be common along the Algerian coast, was identified as *Fierasfer imberbe* and described as having a yellowish ground colour crossed by numerous brown bands, the abdomen bluish and faintly spotted with red. This colour scheme is quite unlike that characteristic of *C. acus*.

The dimensions of the type and paratypes of *C. cuspis* are given in Table IV.

TABLE IV.—Carapus cuspis *n. sp. Measurements and Proportions of Type and Two Paratypes.*

Collection	Monaco	Monaco	British Museum.
Status	Type	Paratypes 1 and 2	
	mm.	mm.	mm.
Total length	216	221	230
Length of head	28 (13·0% TL)	30 (13·6% TL)	31 (13·5% TL)
Maximum depth of head	17 (61% HL)	17 (57% HL)	18 (58% HL)
Maximum width of head	13 (46% HL)	13 (43% HL)	14 (45% HL)
Length of snout	5 (18% HL)	5 (17% HL)	5 (16% HL)
Horizontal diameter of eye	6 (21% HL)	6 (20% HL)	6 (19% HL)
Vertical diameter of eye	5 (18% HL)	5 (17% HL)	5 (16% HL)
Interorbital width	6·5 (23% HL)	6·5 (22% HL)	7 (23% HL)
Length of maxilla	15 (54% HL)	15 (50% HL)	17 (55% HL)
Maximum depth of body	24 (86% HL)	24 (80% HL)	22 (71% HL)
Length of pectoral fin	17 (61% HL)	17 (57% HL)	17 (65% HL)
Preanal length	27 (2·5% TL)	27 (13% TL)	28 (12% TL)

TL = total length ; HL = length of head.

The two new species, *C. birpex* and *C. cuspis*, are both from the same general locality and both bear a superficial resemblance to *C. acus*, to which species they are probably most closely related. They differ from it and from each other especially in their dentition, the size and form of their maxillae and the general shape and proportions of the head, as well as in absolute size. Of the two, *C. birpex* is the furthest removed from *C. acus*. The snout is considerably more pointed than is that of *C. acus* when viewed from the side, squarer when viewed from above (Text-fig. 9). Further, though the head of *C. birpex* is longer than that of the largest *C. acus* available for study, yet the snout is of no greater length. Hence the pre-orbital portion of the skull is relatively shorter in *C. birpex*, the postorbital relatively longer. Another important difference between the two species is the obliquity of the mouth, which in *C. birpex* is so great that the maxilla almost impinges on the ventral profile of the lower jaw, though it does not in fact extend so far behind the orbit as does the maxilla of *C. acus*. Finally, *C. birpex* is separated from *C. acus* by the

possession of enlarged teeth at the front of the upper jaw and by the dual nature of the vomerine teeth, which in form and arrangement are quite unlike those of any other species of *Carapus* so far described. *C. birpex* resembles the Indo-Pacific species *C. homei* in having enlarged jaw teeth, but differs from this species in the absence of an outer row of strong teeth in the lower jaw.

C. cuspis, on the other hand, resembles *C. acus* in many respects, particularly in the dentition of the jaws and the proportions of the head. But the maxilla is relatively shorter than is that of *C. acus*, though the obliquity of the mouth is no greater, and the median row of vomerine teeth are larger and more strongly curved. *C. cuspis* is most clearly distinguished by the depth and rotundity of the abdomen and especially by the constriction of the body at the base of the tail.

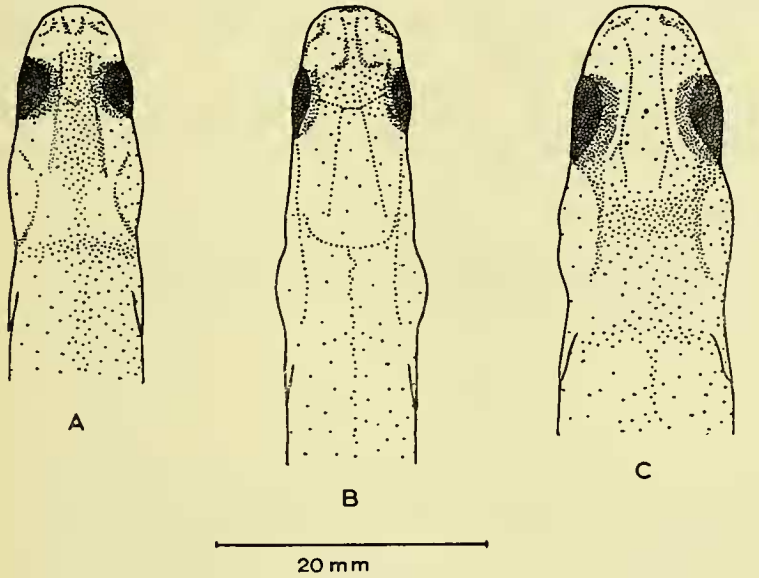

FIG. 9.—Heads of European *Carapus* spp. from the dorsal aspect. A. *C. acus*; B, *C. birpex*; C, *C. cuspis*.

C. acus has been recorded from Atlantic localities upon a number of occasions and under a variety of names:

Madeira, as *Diaphasia acus* (Lowe, 1843).
Canary Islands, as *Fierasfer acus* (Vinciguerra, 1893).
Portuguese coast, as *Fierasfer imberbis* (Nobre, 1935).
Portuguese coast, as *Carapus imberbis* (de Buen, 1935).
West Africa, as *Carapus imberbis* (Fowler, 1936).
Cape Verde Islands, as *Carapus imberbis* (Cadenat, 1937).
Biarritz, as *Fierasfer imberbis* (Pellegrin, 1937).
Senegal, as *Carapus imberbis* (Cadenat, 1950).

Of these authors, two alone (Nobre, 1935 ; Fowler, 1936) provided a description, both of which were based upon Mediterranean specimens, not on those from the locality at which the species was reported. Nobre included a figure, but this is unrecognizable. It seems probable that these records relate either to *C. birpex* or to *C. cuspis*, not to *C. acus* at all.

Carapus dubius (Putnam), 1874

(Text-fig. 10A)

Fierasfer dubius (part) Putnam, 1874, *Proc. Boston Soc. nat. Hist.* **16** : 339. Jordan & Gilbert, 1882, *Bull. U.S. nat. Mus.* **16** : 791.

Fierasfer arenicola Jordan & Gilbert, 1881, *Proc. U.S. nat. Mus.*, **4** : 338. Jordan, 1895, *Proc. Calif. Acad. Sci.* (2) **5** : 502. Jordan & Evermann, 1898, *Bull. U.S. nat. Mus.* **47** : 2183.

Fierasfer affinis, Jordan & Evermann, 1898, *Bull. U.S. nat. Mus.*, **47** : 2183. (non Günther, 1862, *Catalogue of Fishes*, **4** : 381.)

Carapus dubius, Meek & Hildebrand, 1928, *Publ. Field Mus. zool. Ser.* **15** : 963.

Leptofierasfer macrurus Meek & Hildebrand, 1928, *Publ. Field Mus. zool. Ser.* **15** : 963.

Carapus affinis (part), Rivero, 1936, *Proc. Boston Soc. nat. Hist.* **41** : 41. (non Günther, 1862.)

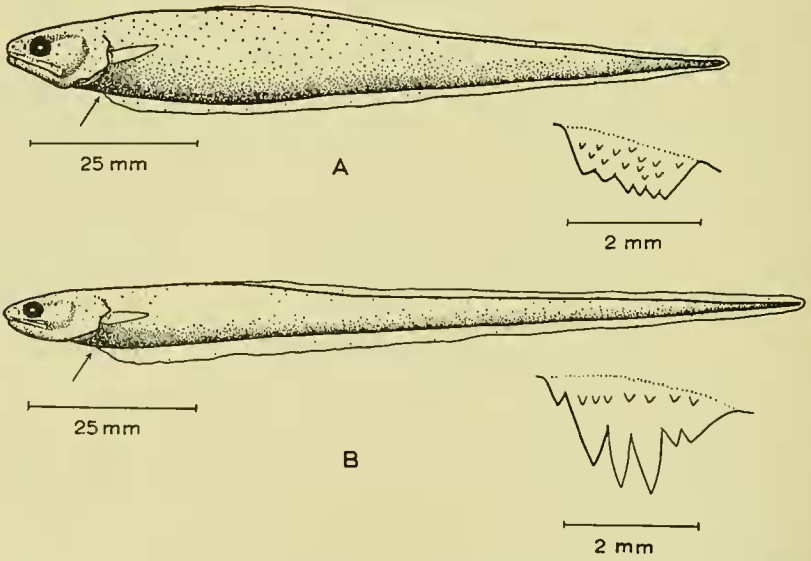

FIG. 10.—A, *Carapus dubius* (Putnam), and its vomerine teeth. B, *Carapus bermudensis* (Jones), and its vomerine teeth.

The following account is based upon a single adult in the collection of the British Museum (Natural History) from the Gulf of Panama.

Putnam did not designate a type. His description was based upon fourteen specimens, eight from Pearl Island, in the Gulf of Panama, the rest from Florida,

the Bahamas and the Tortugas. Most of these specimens, including five from Panama, are in the Museum of Comparative Zoology, Harvard. In Putnam's list of specimens those from Pearl Island stand first ; they must therefore be regarded as the cotypes and Pearl Island, Gulf of Panama, as the type locality.

SPECIFIC CHARACTERS. Maximum length apparently about 100 mm.; head one-seventh to one-eighth of total length ; maximum depth of head one-half to three-fifths and maximum width one-third to two-fifths of length of head ; horizontal diameter of eye equal to length of snout, greater than interorbital width ; mouth slightly oblique ; maxilla extending only a short distance behind posterior edge of orbit ; teeth of upper jaw small, one or two anterior ones enlarged ; outermost series of lower jaw slightly stouter than inner series ; row of about four large, stout, conical teeth on vomer, flanked by smaller ones ; pectoral fin three-fifths length of head ; anus anterior to roots of pectorals ; translucent in life, a few yellowish spots on sides of body, tip of tail dusky (Jordan & Gilbert, 1881). Vexillifer larvae attributable to this species have been described under the name *Leptofierasfer macrurus* Meek & Hildebrand (1928).

The measurements and proportions of the only specimen available for study are given in Table V.

TABLE V.—Carapus dubius (*Putnam*), 1874, *and* C. bermudensis (*Jones*), 1874. *Measurements and Proportions of Adult Specimens.*

Collection	British Museum			
Species	*C. dubius*		*C. bermudensis*	
Museum number	1935.3.24.26		1931.9.24.1	
Locality	Gulf of Panama		Florida	
	mm.		mm.	
Total length	108		104	
Length of head	16	(15% TL)	15	(14% TL)
Maximum depth of head	10	(62·5% HL)	7	(47% HL)
Maximum width of head	7	(44% HL)	5	(33% HL)
Length of snout	3·5	(22% HL)	2·5	(17% HL)
Horizontal diameter of eye	3·5	(22% HL)	2·5	(17% HL)
Vertical diameter of eye	3·2	(20% HL)	2	(13% HL)
Interorbital width	3	(19% HL)	3	(20% HL)
Length of maxilla	8	(50% HL)	6·5	(43% HL)
Length of pectoral fin	10	(62·5% HL)	7	(47% HL)
Maximum depth of body	11	(69% HL)	7·5	(50% HL)
Preanal length	14	(13% TL)	12	(12% TL)

TL = total length ; HL = length of head.

C. dubius has been recorded from the Pacific coast of Central America, including Pearl Island and Chame Point, Gulf of Panama ; Mazatlan, Mexico ; and the Gulf of California. Examples have been found lying free in the sand, but the majority of specimens have been taken as inquilines of lamellibranchs.

The taxonomic status of the fierasfers from the Pacific and Atlantic sides of Central America is a matter concerning which, through lack of specimens, no final

decision can yet be made. In 1874, two species, both undoubted *Carapus*, were described—*Lefroyia bermudensis* Jones from Bermuda and *Fierasfer dubius* Putnam from the Gulf of Panama and West Indies. Neither was figured, the type of *L. bermudensis* cannot be traced, and the original descriptions are distinguishable neither from each other nor from that of the Indo-Pacific species *C. homei*. Most authors have regarded *C. dubius* and *C. bermudensis* as conspecific and many have further equated them with *Fierasfer affinis* Günther. Further complications were introduced by the designation of *Fierasfer arenicola* Jordan & Gilbert and *Leptofierasfer macrurus* Meek & Hildebrand, a vexillifer larva. *Fierasfer arenicola* is now generally accepted as a synonym of *F. dubius*, and the larval nature of *L. macrurus* has also been recognized (Parr, 1930).

Now, it is quite clear that all these forms, whatever their status, belong to the one genus *Carapus*. Further, there is no reason for uniting *F. affinis*, the locality of which is unknown, with the American fierasfers. This species, the type of which is in the British Museum, is far larger than any described from American water and (p. 277) is not distinguishable from *C. homei*.

Putnam based his description of *F. dubius* upon specimens from the Gulf of Panama, but was unable to distinguish them from others from the West Indies. The identity of the two forms is supported by Rivero (1936) who re-examined such of Putnam's specimens as are still available and compared them with other material from Cuba and Jamaica. It appears best, however, to consider these Pacific and Atlantic fierasfers as two closely-related species, pending re-examination of the problem on the basis of more adequate material. The trivial name *dubius* should be restricted to the Pacific fierasfers, while the trivial name *bermudensis* is available for those from the Atlantic.

Carapus bermudensis (Jones), 1874

(Text-fig. 10B)

Lefroyia bermudensis Jones (J. M.), 1874, *Zoologist* (2) **9** : 3837.
Fierasfer dubius (part), Putnam, 1874, *Proc. Boston Soc. Nat. Hist.* **16** : 343. Jordan & Gilbert, 1882, *Bull. U.S. nat. Mus.* **16** : 791.
Fierasfer bermudensis, Jordan & Evermann, 1898, *Bull. U.S. nat. Mus.*, **47** : 2443. Herre, 1942, *Stanford Univ. Publ. biol. Sci.* **7** (2) : 20.
Fierasfer dubius, Parker, 1926, *Proc. nat. Acad. Sci. Washington*, **12** : 421.
Carapus dubius (part), Meek & Hildebrand, 1928, *Publ. Field Mus. zool. Ser.* **15** : 963.
Fierasfer affinis, Breder, 1929, *Field Book of Marine Fishes of the Atlantic Coast* : 279. (non Günther, 1862.)
Carapus affinis, Rivero, 1936, *Proc. Boston. Soc. nat. Hist.* **41** : 41. (non Günther, 1862.)
Carapus sp., juv., Parr, 1930, *Bull. Bingham Oceanogr. Coll.* **3** : 133.
Carapus bermudensis, Longley & Hildebrand, 1941, *Papers Tortugas Lab.* **34** : 90. Beebe & Tee-Van, 1933, *Field Book of the Shore Fishes of Bermuda* : 232.
Fierasfer sp., larva, Herre, 1942, *Stanford Univ. Publ. biol. Sci.* **7** (2) : 20.

The specimens examined are five adults and six larvae in the collection of the British Museum (Natural History). The localities represented are (adults) Florida, Cayman Islands, St. Kitts, Antigua, (larvae) Grenada, Tobago, Antigua. The type was obtained at Bermuda, but is probably no longer in existence.

SPECIFIC CHARACTERS. Maximum length probably less than 150 mm; head one-seventh to one-eighth of total length; maximum depth of head one-half and maximum width two-fifths of length of head; horizontal diameter of eye greater than length of snout and interorbital width; mouth oblique; maxilla not extending far behind posterior edge of orbit; outermost teeth of lower jaw slightly larger than those of inner series; two to four large conical teeth on vomer, flanked by smaller teeth; in upper jaw, anterior teeth enlarged; according to Rivero (1936) there is a single row of small, sharp, backwardly-directed teeth along the outer side of the premaxilla, hidden by the lips, but these are not present in all specimens; pectoral fins two-fifths to one-half length of head; anus anterior to roots of pectoral fins; translucent in life, with irregular transverse reddish bands on trunk and silvery bar along sides (Longley & Hildebrand, 1941). There is a vexillifer larva attributable to this species.

Measurements and proportions of a representative specimen are given in Table V.

C. bermudensis occurs in the west central Atlantic area, including Bermuda, Florida, the Bahamas, Cuba, Jamaica, Cayman Islands, Haiti, Leeward Islands, Windward Islands, Trinidad and Tobago. It is inquiline in the holothurian *Actinopyga agassizi*.

Carapus homei (Richardson), 1844

(Text-fig. 11)

Oxybeles Homei Richardson, 1844, *Ichthyology of the Voyage of H.M.S. Erebus and Terror* : 73. Bleeker, 1855, *Verh. Akad. Amsterdam*, **2** : 15.

Oxybelus Brandesii Bleeker, 1851, *Nat. Tijdschr. Ned.-Ind.* **1** : 278. Bleeker, 1851, *Nat. Tijdschr. Ned.-Ind.* **2** : 228. Bleeker, 1852, *Nat. Tijdschr. Ned.-Ind.* **3** : 238. Bleeker, 1852, *Verh. Bat. Gen.* **24** : 24. Bleeker, 1854, *Nat. Tijdschr. Ned.-Ind.* **7** : 162. Bleeker, 1854, *Nat. Tijdschr. Ned.-Ind.* **7** : 495. Bleeker, 1858, *Nat. Tijdschr. Ned.-Ind.* **15** : 255.

? *Oxybelus lumbricoides* Bleeker, 1854, *Nat. Tijdschr. Ned.-Ind.* **7** : 163.

Fierasfer neglectus Peters, 1855, *Arch. Naturges.* **21** : 260. Günther, 1862, *Catalogue of Fishes*, **4** : 381. Regan, 1908, *Trans. linn. Soc. Lond.* **12** : 220. Barnard, 1927, *Ann. S. Afr. Mus.* **21** : 884.

Fierasfer Homei, Kaup, 1856, *Catalogue of Apodal Fish* : 157. Putnam, 1874, *Proc. Boston Soc. nat. Hist.* **16** : 343. Bleeker, 1863, *Ned. Tijdschr. Dierk.* **1** : 236. Bleeker, 1863, *Ned. Tijdschr. Dierk.* **1** : 272. Bleeker, 1865, *Ned. Tijdschr. Dierk.* **2** : 293. Alleyne & Macleay, 1876, *Proc. linn. Soc., N.S.W.* **1** : 347.

Fierasfer Brandesii, Bleeker, 1858, *Nat. Tijdschr., Ned.-Ind.* **15** : 204. Bleeker, 1858, *Nat. Tijdschr. Ned.-Ind.* **15** : 461.

Fierasfer homei, Günther, 1862, *Catalogue of Fishes*, **4** : 381. Day, 1889, *The Fauna of British India, Fishes*, **2** : 436. Fowler, 1900, *Proc. Acad. nat. Sci. Philadelphia*, **1900** : 523. Johnstone, 1904, *Ceylon Pearl Oyster Fisheries*, 1904, *Suppl. Rep. no.* 15 : 211. Jordan & Everman, 1903, *Bull. U.S. Fish Comm.* **23** : 505. Jordan & Seale, 1905, *Bull. Bur. Fish.* **25** : 435. Jordan & Seale, 1906, *Bull. Bur. Fish.* **26** : 48. Jordan & Snyder, 1906, *Bull. Bur. Fish.* **26** : 217. Regan, 1908, *Trans. linn. Soc. Lond.* **12** : 220.

Fierasfer affinis Günther, 1862, *Catalogue of Fishes*, **4** : 381.

? *Fierasfer lumbricoides*, Bleeker, 1865, *Ned. Tijdschr. Dierk.* **2** : 192. Regan, 1908, *Trans. linn. Soc. Lond.* **12** : 220.

? *Helminthodes lumbricoides*, Gill, 1864, *Proc. Acad. nat. Sci. Philadelphia*, **16** : 203.

Fierasfer acus, Bleeker, 1879, *Verh. Akad. Amsterdam*, **18** : 21.

Fierasfer homii, Waite, 1897, *Mem. Austral. Mus.* **3** : 194.

Fierasfer microdon Gilbert, 1905, *Bull. U.S. Fish Comm.* **23** : 655. Jordan & Seale, 1905, *Bull. Bur. Fish.* **25** : 435.
Fierasfer homei, Steindachner, 1906, *SitzBer. Akad. Wiss. Wien*, **115** : 1419.
Fierasfer Sluiteri Weber, 1913, *Siboga-Expeditie*, **32** : 95.
? *Pirellinus lumbricoides*, Whitley, 1928, *Rec. Austral. Mus.* **16** : 226.
Carapus homei, Fowler & Bean, 1927, *Proc. U.S. nat. Mus.* **71** (10) : 15. Fowler, 1928, *Mem. Bishop Mus.* **10** : 445. Mukerji, 1932, *Rec. Indian Mus.* **34** : 567. Herre, 1936, *Publ. Field Mus. zool. Ser.* **21** : 416. Herre, 1939, *Rec. Indian Mus.* **41** : 574. Abe, 1939, *Palao trop. biol. Stud.* **1** : 574. de Beaufort & Chapman, 1951, *Fishes of the Indo-Australian Archipelago*, **9** : 4496. Smith, J. L. B., 1955, *Ann. Mag. nat. Hist.* (12) **8** : 414.
? *Fierasfer arenicola*, Borodin, 1930, *Bull. Vanderbilt oceanogr.* (*Mar.*) *Mus.* **1** : 62.
Fierasfer Mourlani Petit, 1934, *Bull. Mus. Hist. nat. Paris*, **6** : 393.
Carapus neglectus, Smith (J. L. B.), 1949, *Sea Fishes of Southern Africa* : 359. Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (12) **8** : 413.

The specimens examined include the type and 48 others (27 adults, 2 tenuis, the rest probably juveniles) in the collection of the British Museum. The localities represented are the Seychelles, Laccadives, Chagos Archipelago, Zanzibar, Dar-es-Salaam, Saya de Malha bank, Madras, Raiatea, Fiji, Tahiti, Rotuma, Samoa, Misol, New Guinea, Solomon Islands, Amboyna and Woosung.

Richardson studied three specimens, two obtained by Sir James Ross during the voyage of H.M.S. " Erebus " and " Terror " (one of which was dissected) and another sent to the Royal College of Surgeons from Timor, where it had been found in a holothurian. The locality of the first two specimens is unknown, though Richardson believed it might be Tasmania. However, this species has not subsequently been reported further south than the latitude of New Caledonia. Only one of the three specimens is still in existence and this is in the collection of the British Museum (Natural History), no. 1952.10.30.3. The type locality is generally stated as Tasmania but should probably be given as Timor.

Specific characters. Maximum length *c.* 200 mm. ; length of head one-sixth to about one-seventh of total length ; maximum depth of head one-half to three-fifths and maximum width two-fifths to one-half of length of head ; specimens less than 100 mm. long have relatively shorter and more slender heads than have larger specimens horizontal diameter of eye greater than length of snout, equal to interorbital width ; maxilla extends behind orbit to a distance equal to half horizontal diameter of eye ; one or two anterior teeth in upper jaw enlarged, the rest extremely small ; teeth of outermost series in lower jaw larger and stouter than those of inner series, bulging out a little beyond the edge of the jaw bone ; central row of usually three or four large, conical or slightly curved teeth on vomer, flanked by smaller ones ; pectoral fins half length of head ; anus anterior to roots of pectorals ; translucent in life with bluish or reddish shades anteriorly, dark cross-bars when adult (Jordan & Seale, 1905) ; silver spot between hind part of eye and maxilla in most specimens and a series of silver patches on flanks above lateral line. *Oxybeles lumbricoides* Bleeker is probably a tenuis larva of this species.

Measurements and proportions of the type and of representative adults are given in Table VI, and a summary of the principal measurements of the adults studied in Table VII.

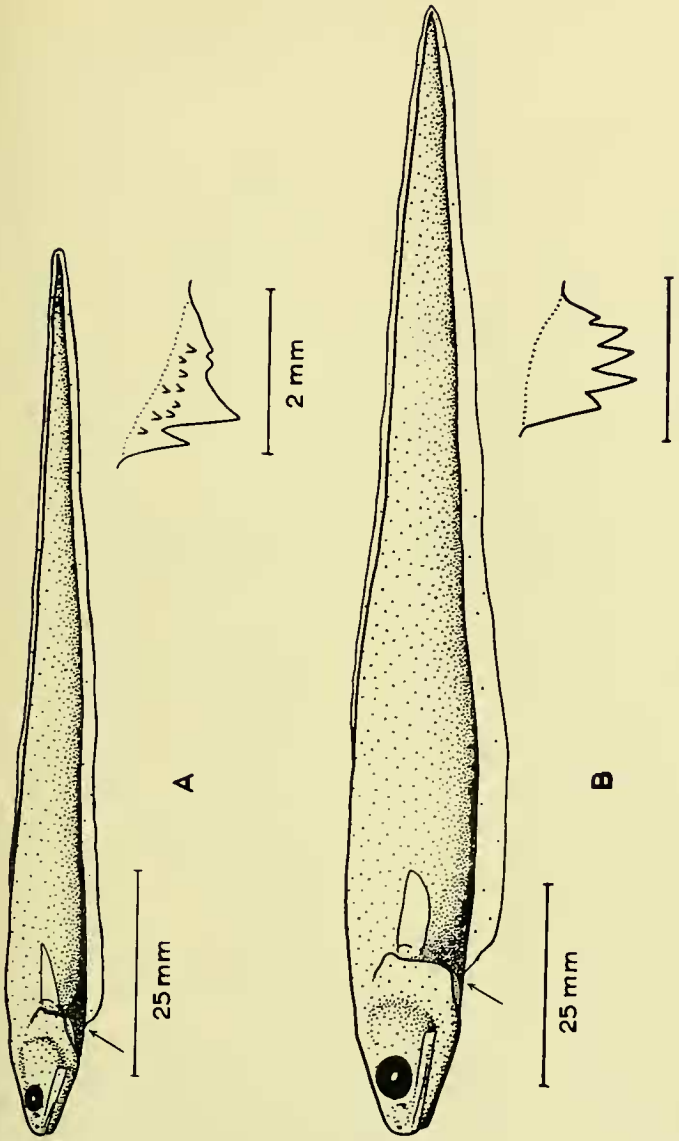

FIG. 11.—*Carapus homei* (Richardson). A, The type and its vomerine teeth; B, a representative specimen from the Indian Ocean, and its vomerine teeth.

TABLE VI.—Carapus homei (*Richardson*). *Measurements and Proportions of the Type and of Representative Adults.*

Collection	British Museum		
Number	1952.10.30.3	1875.3.3.8	1908.3.23.36
Locality	?	Samoa	Saya de Malha
	mm.	mm.	mm.
Total length	109*	142	139
Length of head	16 (15% TL)	20 (14% TL)	22 (16% TL)
Maximum depth of head	9 (56% HL)	10 (50% HL)	12 (55% HL)
Maximum width of head	7 (44% HL)	7 (35% HL)	10 (45% HL)
Length of snout	3 (19% HL)	4 (20% HL)	4 (18% HL)
Horizontal diameter of eye	3·5 (22% HL)	5 (25% HL)	5 (23% HL)
Vertical diameter of eye	3 (19% HL)	4·5 (22% HL)	4·5 (20% HL)
Interorbital width	2·5 (16% HL)	4 (20% HL)	4 (18% HL)
Length of maxilla	8·5 (53% HL)	11 (55% HL)	11·5 (52% HL)
Length of pectoral fin	8 (50% HL)	13 (65% HL)	10 (45% HL)
Maximum depth of body	9 (56% HL)	13 (65% HL)	15 (68% HL)
Preanal length	14 (13% TL)	17 (12% TL)	20 (14% TL)

* Type specimen.

TL = total length ; HL = length of head.

TABLE VII.—Carapus homei (*Richardson*). *Summary of Measurements and Proportions of Adult Fish.*

Variate.	N.	R. mm.	M ± σ_M. mm.
Total length	27	100–190	138·6±5·09
Length of head	27	15–30	20·0±0·76
Depth of head	27	8–16	10·2±0·61
Width of head	27	5–14	8·1±0·60
Length of pectoral fin	26	7–15	10·4±0·78
Preanal length	26	13–27	17·7±0·80
		%	%
Length of head (% TL)	27	12·8–17·0	14·6±0·19
Depth of head (% HL)	27	50·0–60·0	54·3±0·18
Width of head (% HL)	27	32·0–50·0	41·5±0·93
Length of pectoral (% HL)	26	40·0–65·0	50·6±0·89
Preanal length (% TL)	26	10·5–11·4	12·6±0·21

N = number of specimens ; R = range of variate ; M = mean of variate (± standard error of mean σ_M) ; TL = total length ; HL = length of head.

C. homei has a wide distribution and more extensive collections might show that it should be broken up into subspecies ; this, however, is not possible with the material at present available. It has been reported from Ghardaqa in the Red Sea, various Indian Ocean localities, Indonesian waters, the Philippines, Celebes, Torres Straits, off the coast of Queensland, Hawaii, Woosung, Palao and many localities in the South Pacific. It has been found mainly in species of *Holothuria*, *Actinopyga* and

Stichopus, but also occasionally in other echinoderms (*Culcita*, *Nardoa*) and lamellibranchs (*Cardium*, *Pinctada*) and once in an ascidian (*Styela*).

Several nominal species have been described from within the range of *C. homei*, which have differed from it solely in point of size and of number of vomerine teeth, neither of which, alone or together, can be regarded as good diagnostic characters. Two of these forms, *Fierasfer brandesii* Bleeker and *Fierasfer sluiteri* Weber, are now generally accepted as synonymous with *C. homei*, while two others, *Fierasfer microdon* Gilbert from Hawaii and *Fierasfer mourlani* Petit from Madagascar, are not distinguishable in description from the smaller specimens of *C. homei*. None of these four forms has been recorded by other than the original authors, but two others, *Fierasfer neglectus* Peters from Mozambique and *Fierasfer affinis* Günther of unknown origin, have been recorded upon a number of subsequent occasions and therefore merit more detailed consideration.

F. neglectus was well described, though not figured, and there are in the British Museum collection a number of fierasfers from Indian Ocean localities that are clearly referable to this species. However, this group bears an equally close resemblance to the *C. homei* specimens from Indo-Australian and Pacific waters, especially in the dentition and the general presence of a suborbital silver patch. Specimens of similar size from the two areas have almost identical proportions. The two groups show small differences but comparison shows these differences to be too small for it to be impossible for them to have been drawn from the same " population ". *F. neglectus* may ultimately be found to be subspecifically distinct, but with the material at present available it is not possible clearly to diagnose to which group, Indic or Pacific, any given specimen belongs.

F. affinis, of which the type only is known, has been regarded by most American authors as a fierasfer from American waters. This, however, is erroneous. It is 174 mm. in length, far larger than any fierasfer yet recorded from the coastal waters of Central America ; the dentition is wholly that of *C. homei* ; there is a suborbital silver spot ; and its dimensions fit closely with those of the available sample of *C. homei*, especially those of the Pacific group. Comparison of the main characters of this specimen with those of the available sample of *C. homei* give values of d/σ which are well below 3·0, the minimum value usually taken as suggesting specific difference (Simpson & Roe, 1947).

Carapus pindae Smith, 1955

Carapus pindae Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (12) 8 : 412.

The type, the only specimen known, was found inside an unidentified holothurian taken at Pinda (14° 10′ S., 40° 40′ E.) and is lodged in the Department of Ichthyology, Rhodes University, Grahamstown, South Africa. It has not been available for study and the following account is derived entirely from the original description.

Specific characters. Total length 75 mm.; length of head one-seventh of total length ; width of head about one-third, depth of head about one-half, of length of head ; horizontal diameter of eye twice as great as interorbital width, one-half as great again as length of snout ; maxilla extending behind orbit for distance less

than one-half horizontal diameter of eye ; teeth in single series in upper jaw, the first pair enlarged ; teeth in bands in lower jaw, none enlarged ; palatine teeth uniserial posteriorly, polyserial anteriorly ; two large and several small teeth on vomer ; pectoral fins slightly less than one-half length of head ; anus anterior to roots of pectoral fins ; translucent in life with pink sheen, abdomen silvery-bronze, row of silvery-bronze spots on sides of abdomen, faint dusky cross-bars on back.

The measurements of this specimen are not stated, but a series of proportions are given in the original description.

This species is closest to *C. homei*, but differs from it and all other fierasfers so far described in the partially uniserial nature of the dentition. Its small size suggests that *C. pindae* may not be fully mature, in which case the peculiarities of the dentition might be only transient. Should this indeed be the case, there seems little to justify separation of this species from *C. homei* as at present comprehended.

Carapus kagoshimanus (Steindachner & Döderlein), 1877

Fierasfer kagoshimanus Steindachner & Döderlein, 1877, *Denkschr. Akad Wiss. Wien.* **53** : 1. Jordan & Snyder, 1901, *Annot. zool. jap.* **3** : 118.

Carapus kagoshimanus, Jordan & Fowler, 1903, *Proc. U.S. nat. Mus.* **25** : 743. Franz, 1910, *Abhandl. Bayer Akad. Wiss., Suppl.* **4** : 31.

The type was obtained in the harbour at Kagoshima, Japan and its present whereabouts are unknown. No specimens have been available for study and the following account is based upon those of the authorities cited above.

SPECIFIC CHARACTERS. Length of type 110 mm.: head one-seventh of total length ; maximum depth of head three-fifths, maximum width two-fifths, of length of head ; horizontal diameter of eye equal to length of snout and to interorbital width ; teeth of jaws, palatines and vomer small ; anus beneath base of pectoral fins ; pectorals less than half length of head ; colour stated as uniform pink with dark spots.

This species has been reported only from Kagoshima and Sagami.

Carapus owasianus Matsubara, 1953

Carapus owasianus Matsubara, 1953, *Jap. J. Ichthyol.* **3** : 29.

The type, the only specimen known, was taken free-swimming off the coast near Owasi, Japan, and placed in Matsubara's Fish Collection, no. 18871. It has not been available for study and the following account is compiled from the original description.

SPECIFIC CHARACTERS. Total length about 200 mm. (determined from figure, not stated by author) ; head over one-eighth of total length ; horizontal diameter of eye a little greater than length of snout, nearly twice as great as interorbital width ; maxilla extending behind orbit for a distance approximately equal to half horizontal diameter of eye ; enlarged teeth at front of both jaws ; vomerine teeth small ; anus slightly posterior to roots of pectorals ; pectoral fins half length of head ; colour in life unknown.

The measurements of this specimen have not been recorded, but its detailed proportions are listed in the original publication.

Carapus houlti (Ogilby), 1922

Fierasfer houlti Ogilby, 1922, *Mem. Queensland Mus.* **7** : 301.
Carapus houlti, McCulloch, 1929, *Mem. Austral. Mus.* **5** : 354.

The two cotypes, the only specimens known, were taken together off Double Island Point, southern Queensland, in 36 fathoms (70 metres) enclosed in the remains of an unidentified holothurian. They have not been available for study and the following account is compiled from the original description.

SPECIFIC CHARACTERS. The two specimens were 283 mm. and 236 mm. long ; head one-seventh to one-eighth of total length ; width of head one-half its length ; maximum depth of body considerably greater than maximum depth of head ; teeth in jaws small and conical, uniform in size ; row of four large teeth on vomer ; anus beneath roots of pectorals ; pectoral fins a little less than one-third length of head ; colour greyish-brown with darker dots.

Carapus boraborensis (Kaup), 1856

Fierasfer boraborensis Kaup, 1856, *Arch. Naturges.* **22** : 97. Kaup, 1856, *Catalogue of Apodal Fishes* : 160.
Jordanicus boraborensis, Jordan & Seale, 1905, *Bull. Bur. Fish.* **25** : 435. Fowler, 1928, *Mem. Bishop Mus.* **10** : 446. Fowler, 1938, *Mon. Acad. nat. Sci., Philadelphia* **2** : 260.

The original description is based upon several specimens obtained by Lesson and Carnot at Borabora in the Samoan Archipelago and placed in the Paris Museum. They seem to be no longer in existence and no examples have been available for study.

SPECIFIC CHARACTERS. Kaup's two accounts are brief, unillustrated and in part contradictory. In the first the length is given as 330 mm., with the head one-eleventh of the total length and the pectoral fins one-third to one-quarter the length of the head; no other characters are mentioned. The second account records also the vomerine teeth and preanal length. In this description the largest specimen is said to be 23 in., or about 580 mm., in length ; the head is once again given as one-tenth to one-eleventh of the total length, but the pectoral fins are said to be one-sixth the length of the head. This fish has a cluster of thick teeth on the vomer and the anus is situated nearly 30 mm. anterior to the roots of the pectoral fins.

This may not be a single species, nor even a fierasfer at all. It has been included in lists of the Samoan fish fauna (Jordan & Seale, 1905 ; Fowler, 1928 & 1938), but the citations are from Kaup and the species has not been seen since. There is no evidence to justify the inclusion of this rather doubtful form in *Jordanicus*.

Carapus parvipinnis (Kaup), 1856

(Text-fig. 12)

Fierasfer parvipinnis Kaup, 1856, *Arch. Naturges.* **22** : 97. Kaup, 1856, *Catalogue of Apodal Fishes* : 160. Günther, 1862, *Catalogue of Fishes*, **4** : 381. Fowler, 1900, *Proc. Acad. nat. Sci., Philadelphia*, **1900** : 523. Kendall & Goldsborough, 1911, *Mem. Mus. comp. Zool. Harvard*, **26** : 330. Weber, 1913, *Siboga Expeditie*, **32** : 96. Tortonese, 1939, *Boll. Mus. Zool. Anat. comp. Torino*, **47** : 379.

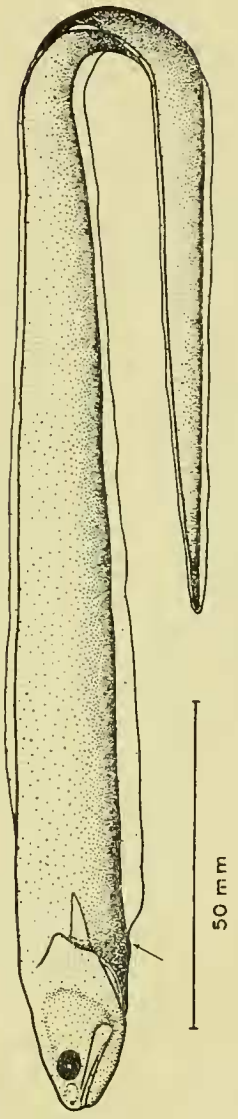

FIG. 12.—*Carapus parvipinnis* (Kaup). A representative specimen and its vomerine teeth.

Jordanicus parvipinnis, Jordan & Seale, 1905, *Bull. Bur. Fish.* **25** : 435. Fowler, 1925. *Proc. Acad. nat. Sci., Philadelphia*, **77** : 264. Fowler, 1928, *Mem. Bishop Mus.* **10** : 447. Fowler, 1938, *Mon. Acad. nat. Sci., Philadelphia*, **2** : 260.

Carapus parvipinnis, Herre, 1936, *Publ. Field Mus. zool. Ser.* **21** : 416. Abe, 1939, *Palao trop. biol. Stud.* **1** : 575. Herre & Herald, 1950, *Philipp. J. Sci.* **79** : 337. Smith (J. L. B.), 1955, *Ann. mag. nat. Hist.* (12) **8** : 412.

The study material includes 12 adults in the collection of the British Museum (Natural History) and one in that of the Universitetets Zoologiske Museum, Copenhagen. The localities represented are Tahiti, Ponapé, Samoa, Rotuma, Raiatea, Banda and Mauritius. The type was obtained by Quoy and Gaimard at Carteret Harbour and probably placed in the Paris Museum. It seems to be no longer in existence.

Specific characters. Maximum length about 300 mm.; length of head one-ninth to less than one-tenth of total length ; maximum depth of head about two-fifths and maximum width about one-half of length of head ; eye well below dorsal profile of head ; its horizontal diameter half as long again as length of snout, slightly less than interorbital width ; maxilla very stout, extending behind orbit for a distance equal to horizontal diameter of eye ; jaw teeth small, nearly uniform, a few at front of lower jaw smaller than rest ; three or four large, stout, conical teeth on vomer, surrounded by smaller teeth ; pectoral fins one-third to one-quarter length of head ; anus anterior to roots of pectorals. Of four specimens obtained alive at Moorea Island, Tahiti, two were a warm red-brown colour, the other two pale and translucent (Herre, 1936*b*). One reddish fish was certainly adult ; the pale fish may have been juveniles.

Measurements and proportions of representative adults are given in Table VIII, and a summary for the adults examined in Table IX.

Table VIII.—Carapus parvipinnis (*Kaup*). *Measurements and Proportions of Representative Adults.*

Collection	British Museum.			
Number	1929.8.4.1.		1874.11.19.31.	
Locality	Tahiti.			
	mm.		mm.	
Total length	195		260	
Length of head	21	(11% TL)	28	(11% TL)
Maximum depth of head	13	(62% HL)	16	(57% HL)
Maximum width of head	13	(62% HL)	12	(43% HL)
Length of snout	3	(14% HL)	4·5	(16% HL)
Horizontal diameter of eye	4	(19% HL)	5	(18% HL)
Vertical diameter of eye	3·5	(17% HL)	4·5	(16% HL)
Interorbital width	5	(24% HL)	7·5	(27% HL)
Length of maxilla	10	(48% HL)	12·5	(45% HL)
Length of pectoral fin	6	(29% HL)	8	(29% HL)
Maximum depth of body	14·5	(69% HL)	16	(57% HL)
Preanal length	21	(11% TL)	27	(10% TL)

TL = total length ; HL = length of head.

TABLE IX.—Carapus parvipinnis (*Kaup*). *Summary of Measurements and Proportions of Adults.*

Variate.	N	R. mm.	M. mm.
Total length	10	167–295	224·9
Length of head	10	18–33	24·3
Depth of head	10	10–21	14·8
Width of head	10	8–21	12·6
Pectoral length	10	4–9	6·9
Preanal length	8	18–33	25·0
		%	%
Head length (% TL)	10	9·55–11·67	10·8
Head depth (% HL)	10	55·56–65·38	60·7
Head width (% HL)	10	42·10–63·64	51·8
Pectoral length (% HL)	10	19·05–37·50	28·3
Preanal length	8	9·05–11·19	10·6

N = number of specimens ; R = range of variate ; M = mean value of variate ; TL = total length ; HL = length of head.

This species has been assigned (Jordan & Seale, 1905) to *Jordanicus* on account of the relatively great width of the head, even though it possesses neither of the other characters—adnate maxillae and absence of a lower lip—by which this genus was originally separated from *Carapus*. Instead, *C. parvipinnis* closely resembles *C. acus* in the form of its vertebrae, the shape of the lower jaw and the nature of the dentition. The most striking difference between this species and the other *Carapus* spp. is the relatively small size of the head which, when combined with the cylindrical body form, does cause it to approach *Encheliophis* (*Jordanicus*) *gracilis* in general appearance. However, this resemblance is purely superficial and provides no grounds for placing *C. parvipinnis* in any genus but *Carapus*.

C. parvipinnis occurs in the tropical Pacific, especially at Tahiti, Samoa and the Philippine and Solomon Islands, as an inquiline of holothurians. One specimen in the collection of the British Museum was obtained in Mauritius. It has relatively longer pectorals than have the Pacific Ocean specimens, but this may be merely an individual peculiarity.

Carapus caninus (Günther), 1862

(Text-fig. 13)

Fierasfer caninus Günther, 1862, *Catalogue of Fishes*, **4** : 381. Sauvage, 1891, *Histoire Naturelle des Poissons* : 476.
Jordanicus caninus, Fowler, 1927, *Bull. Bishop Mus., Honolulu*, **38** : 30. Fowler, 1928, *Mem. Bishop Mus.* **10** : 447. Fowler, 1938, *Mon. Acad. nat. Sci. Philadelphia*, **2** : 260.
Jordanicus fowleri, Smith (J. L. B.) 1955, *Ann. Mag. nat. Hist.* (12) **8** : 402.
Carapus mayottae, Smith (J. L. B.) 1955, *Ann. Mag. nat. Hist.* (12) **8** : 415.

The following account is based upon a re-examination of the type, no. 1952.10.30.2 in the collection of the British Museum (Natural History) ; locality unknown.

SPECIFIC CHARACTERS. Total length of type is 83 mm.; body slender and strongly compressed, but not deeper than head ; head one-seventh of total length ; maximum depth of head one-half and maximum width one-third of length of head ; horizontal diameter of eye equal to length of snout, half as great again as interorbital width ; maxilla extends behind orbit for a distance equal to half horizontal diameter of eye ; outer row of teeth of lower jaw tall, curved, well-separated from each other, those at the front the largest ; inner teeth of lower jaw small, conical, close-set ; teeth of

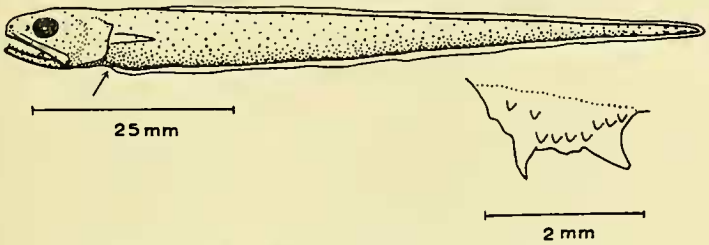

FIG. 13.—*Carapus caninus* (Günther). The type and its vomerine teeth.

upper jaw small, conical, pair at front greatly enlarged ; vomerine teeth in a single row as large as outermost teeth of lower jaw ; pectoral fins one-third length of head ; anus below roots of pectorals ; colour in life unknown.

Measurement of this specimen are given in Table X.

TABLE X.—Carapus caninus (*Günther*). *Measurements and Proportions of the type.*

Museum	British Museum.		
Number	1952.10.30.2.		
	mm.		
Total length	88		
Length of head	13	(15% TL)	
Maximum depth of head	7	(54% HL)	
Maximum width of head	4	(31% HL)	
Length of snout	3	(23% HL)	
Horizontal diameter of eye	3	(23% HL)	
Vertical diameter of eye	2·5	(19% HL)	
Interorbital width	2	(15% HL)	
Length of maxilla	7·5	(57% HL)	
Length of pectoral fin	5	(39% HL)	
Maximum depth of body	6	(46% HL)	
Preanal length	13	(15% TL)	

TL = total length ; HL = length of head.

This species has also been recorded from Mayotte (Sauvage, 1891), host, if any, not stated ; and from Christmas Island (Fowler, 1927) when two specimens were taken in a pearl-oyster.

Smith (1955), believing that the type is no longer in existence, has suggested that the trivial name *caninus* should be abandoned and has proposed instead the names *Carapus mayottae* for the specimen from Mayotte and *Carapus fowleri* for those from Christmas Island. However, *Carapus caninus* is unquestionably valid and, though it has not been possible to examine the other specimens attributed to this species, the published descriptions and figures are not sufficiently at variance with Günther's type to warrant specific separation. Fowler's inclusion of *C. caninus* in *Jordanicus* is also incorrect.

Subgenus *ONUXODON*

SUBGENERIC CHARACTERS. Body strongly compressed, its greatest depth equal to length of head; interorbital strongly domed, its width less than horizontal diameter of eye; trunk vertebrae 19–20; swim-bladder partly calcified.

KEY TO SPECIES

Pectoral fins less than one-quarter length of head . .	*C. (Onuxodon) parvibrachium.*
Pectoral fins more than one-half length of head . .	*C. (Onuxodon) margaritiferae.*

Carapus (Onuxodon) parvibrachium Fowler, 1927

(Text-fig. 14)

Carapus parvibrachium Fowler, 1927, *Bull. Bishop Mus.* **38** : 30. Fowler, 1928, *Mem. Bishop Mus.* **10** : 445.
Onuxodon parvibrachium, Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (12) **8** : 406.

The following account is based upon a single specimen obtained by Dr. T. Mortensen at Banda, Indonesia, and placed in the collection of the Universitetets Zoologiske Museum, Copenhagen. The holotype and one paratype were taken in Suva Bay, Fiji, in an unidentified clam-shell and placed in the Bernice P. Bishop Museum, Honolulu, Hawaii.

SPECIFIC CHARACTERS. Total length 67 mm. (type and paratype were 81 mm. and 71 mm. respectively); length of head rather less than one-seventh of total length; maximum depth of head a little less than three-quarters and maximum width two-fifths of length of head; maximum depth of body equal to length of head; horizontal diameter of eye slightly greater than length of snout, two and a half times as great as interorbital width; maxilla extending behind orbit for a distance greater than horizontal diameter of eye; anterior pair of teeth in each jaw very large, the rest of the dentition minute; pectoral fins a little more than one-fifth length of head; translucent in life with pink sheen and dark markings on snout, at bases of dorsal and anal fins and on caudal region (Smith, 1955).

Measurements and proportions of this specimen are given in Table XI.

TABLE XI.—Carapus (Onuxodon) parvibrachium *Fowler. Measurements and Proportions of an Adult from Banda in the Collection of the Universitetets Zoologiske Museum, Copenhagen.*

	mm.	
Total length	67	
Length of head	9	(13% TL)
Maximum depth of head	7	(78% HL)
Maximum width of head	3·5	(39% HL)
Length of snout	2	(22% HL)
Horizontal diameter of eye	2·5	(28% HL)
Vertical diameter of eye	2	(22% HL)
Interorbital width	1	(11% HL)
Length of maxilla	6	(67% HL)
Length of pectoral fin	2	(22% HL)
Maximum depth of body	9	(100% HL)
Preanal length	11	(16% TL)

TL = total length ; HL = length of head

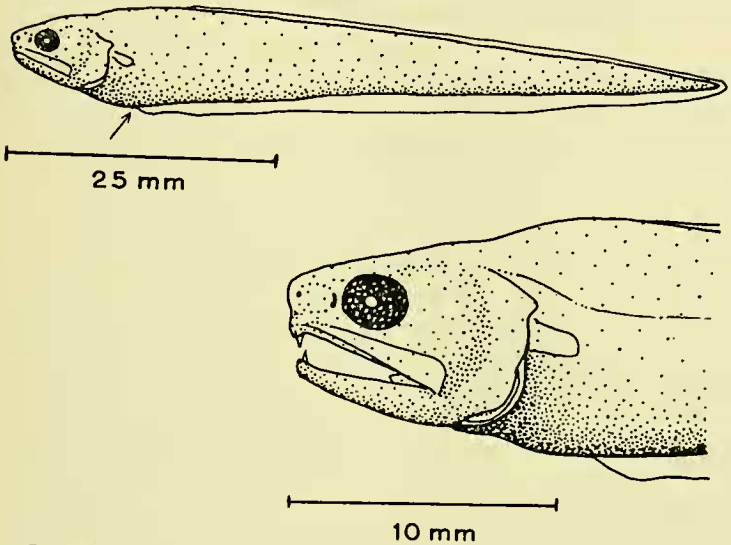

FIG. 14.—*Carapus (Onuxodon) parvibrachium* Fowler. A specimen from Bandu, Indonesia.

Carapus (Onuxodon) margaritiferae (Rendahl), 1921

(Text-fig. 15)

Fierasfer homei Weber, 1913, *Siboga Expeditie*, **32** : 95. (non Richardson, 1844, *Ichthyology of the Voyage of H.M.S. "Erebus" and "Terror"* : 73.)
Fierasfer margaritiferae Rendahl, 1921, *K. Svenska Vetensk. Akad. Handl.* **61** (9) : 5.
Carapus margaritiferae, de Beaufort & Chapman, 1951, *Fishes of the Indo-Australian Archipelago*, **9** : 449. Smith (J. L. B.), *Ann. Mag. nat. Hist.* (12) **8** : 400.
? *Fierasfer homei* (part), Abe, 1939, *Palao trop. biol. Stud.* **1** : 574.

The study material includes 11 adults in the collection of the Universitetets Zoologiske Museum, Copenhagen. Localities represented are Banda and Cape Jaubert. The type was taken from a pearl oyster dredged off Cape Jaubert, northwest Australia, and was placed in the Swedish Museum.

SPECIFIC CHARACTERS. Greatest recorded length 92 mm.: length of head one-sixth to one-seventh of total length; maximum depth of head three-fifths and maximum width one-third of length of head; horizontal diameter of eye less than length of snout, twice as great as interorbital width; mouth nearly horizontal; maxilla extends behind orbit for a distance greater than horizontal diameter of eye; oval patch of many small teeth on vomer; pectoral fins one-half to three-fifths of length of head; translucent in life with pink sheen, caudal dusky (Smith, 1955).

FIG. 15.—*Carapus* (*Onuxodon*) *margaritiferae* (Rendahl). A representative specimen from Cape Jaubert, Australia.

Measurements of representative specimens are given in Table XII, and a summary of measurements and proportions of the adult fish studied in Table XIII.

TABLE XII.—Carapus (Onuxodon) margaritiferae (*Rendahl*). *Measurements and Proportions of Representative Adults in the Collection of the Universitetets Zoologiske Museum, Copenhagen.*

Locality	Banda.	C. Jaubert.
	mm.	mm.
Total length	68	82
Length of head	9 (13% TL)	12 (15% TL)
Maximum depth of head	5 (56% HL)	8 (67% HL)
Maximum width of head	3·5 (39% HL)	5 (42% HL)
Length of snout	2 (22% HL)	3 (25% HL)
Horizontal diameter of eye	1·3 (14% HL)	1·5 (21% HL)
Vertical diameter of eye	1 (11% HL)	2 (17% HL)
Interorbital width	0·7 (8% HL)	1·5 (12% HL)
Length of maxilla	5 (56% HL)	7 (58% HL)
Length of pectoral fin	6 (67% HL)	7 (58% HL)
Maximum depth of body	7 (78% HL)	9·5 (79% HL)
Preanal length	9·5 (14% TL)	12 (15% TL)

TL = total length; HL = length of head.

TABLE XIII.—Carapus (Onuxodon), margaritiferae (*Rendahl*).
Summary of Measurements and Proportions of Adults examined.

Variate.	N.	R. mm.	M. mm.
Total length	10	53–82	68·8
Length of head	10	5–12	9·3
Depth of head	10	3–8	5·7
Width of head	9	1·5–5	3·3
Length of pectoral fin	9	2–7	5·6
Preanal length	9	8–12	9·7
		%	%
Length of head (% TL)	10	8·93–15·38	13·23
Depth of head (% HL)	10	50·00–71·43	61·24
Width of head (% HL)	9	30·00–57·14	38·58
Pectoral length (% HL)	9	40·00–71·43	57·47
Preanal length (% TL)	9	13·11–14·47	13·59

N = number of specimen; R = range of variate; M = mean value of variate; TL = total length; HL = length of head.

C. margaritiferae has been found mainly in the Indo-Australian region, where it has been recorded from Cape Jaubert, Flores, Saleyer and Banda in the lamellibranchs *Avicula* and *Pteria*, in pearl oysters, and once in a holothurian. Five fierasfers taken at Palao (Abe, 1939) in *Pinctada maxima* may also belong to this species, while Smith (1955) has recorded it from clams at Durban.

Carapus reedi Smith, 1955

Carapus reedi Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (12) 8, p. 410.

The type, the only specimen known, was found in a clam shell taken in 2 fathoms at Durban and is lodged in the Department of Ichthyology, Rhodes University, Grahamstown, South Africa. It has not been available for study and the following account is based entirely upon the original description.

SPECIFIC CHARACTERS. Total length about 70 mm.; head about one-fourteenth of total length; maximum width of head about one-quarter, maximum depth nearly as great as length of head; diameter of eye equal to length of snout, twice as great as interorbital width; maxilla extends only as far as posterior edge of orbit; jaw and palatine teeth small, uniserial; anterior pair of teeth in each jaw enlarged; vomerine teeth few, small; pectoral fins two-thirds length of head; anus posterior to base of pectorals; translucent in life with pink sheen, few black spots on top of head.

Measurements of this specimen have not been published, but detailed proportions are given in the original description.

This specimen is clearly not a vexillifer larva, as are so many of the apparently aberrant fierasfers that have been described, but its small size, short maxilla, uniserial dentition and relatively short head form a combination of characters which suggest that it has not yet attained full maturity. From the illustration it is undoubtedly

a *Carapus*, while the proportions of the head suggest that it should be placed in the subgenus *Onuxodon*. If it is indeed a late tenuis larva or early juvenile, it is probably attributable to the preceding species, *C. margaritiferae*.

Genus ***ECHIODON*** Thompson, 1837

Genotype ***Echiodon Drummondii*** Thompson, 1837

Echiodon Thompson, 1837, *Proc. zool. Soc. Lond.* **5** : 55. Type species *Echiodon Drummondii* Thompson, 1837.
Ophidium (*Echiodon*), Thompson, 1841, *Trans. zool. Soc. Lond.* **2** : 207.

Generic characters. Body elongated, cylindrical; lateral processes of first and second vertebrae expanded, not fused; processes of all other vertebrae small and not expanded; trunk vertebrae number 27–28; lower jaw stout, nearly straight, narrowing at distal end, then expanding again at extreme tip; one or two pairs of large, fang-like teeth at front of both jaws; other jaw teeth small and close-set in narrow bands; anterior fangs of lower jaw separated from other teeth by a large diastema; maxilla extending beyond orbit in adult, clearly outlined by folds of skin; anus posterior to roots of pectorals in adult; upper edge of orbit impinging on dorsal profile of skull; swim-bladder long and straight, not constricted; branchiostegals 7.

The genus *Echiodon* was first created to contain the newly discovered species *E. drummondi*. Subsequently, its author reduced it to subgeneric rank under *Ophidium* and Kaup (1856*a*) united it with *Fierasfer*. Later authors have followed Kaup, but the differences between *E. drummondi* and most other fierasfers are so clear-cut that it is necessary to re-establish the genus, not only for the original species, but also for that originally described as *Ophidium dentatum* Cuvier (1817).

Echiodon differs from both *Carapus* and *Encheliophis* in both vertebral and jaw structure, in the clearly posterior position of the anus in the adult and in the presence of a diastema at the front of both jaws. It is further distinguished from *Encheliophis* in the possession of polyserial dentition and from *Carapus* in the relative shortness of the head.

Key to Species, Adults only

Upper profile of head rounded vomer tapering posteriorly; no gap between vomerine and palatine teeth . . . . . *E. drummondi*
Upper profile of head straight; vomer rounded posteriorly; distinct gap between vomerine and palatine teeth . . . . . *E. dentatus*

Echiodon drummondi Thompson, 1837

(Text-fig. 16)

Echiodon drummondii Thompson, 1837, *Proc. Zool. Soc. Lond.* **5** : 52. Yarrell, 1852, *Proc. Zool. Soc. Lond.* **20** : 14. Edward, 1863, *Zoologist* (1) **21** : 8495. Couch, 1864, *History of the Fishes of the British Isles*, **3** : 133.
Ophidium (*Echiodon*) *drummondii*, Thompson, 1841, *Trans. zool. Soc. Lond.* **2** : 207.

Fierasfer dentatus Kaup, 1856, *Catalogue of Apodal Fish* : 157. (non *Ophidium dentatum* Cuvier, 1817, *Règne Animal*, **2** : 239.) Günther, 1862, *Catalogue of Fishes*, **4** : 381. Day, 1880, *The Fishes of Great Britain and Ireland*, **1** : 228. Colett, 1882, *Forh. VidenskSelsk.*, *Kristiania*, **1882**, (19) : 5. Sim. 1883, *Scottish Nat.*, **7** : 55. Fries, Ekström & Sundevall, 1893, *History of Scandinavian Fishes*. **2** : 260. Aflalo, 1904, *British Salt-water Fish* : 294. Ehrenbaum-Helgoland, 1909, *Nord Plank*. **10** : 217. Grieg, 1911, *Bergen Mus. Aarbok*. **1911** (6) : 17. Ehrenbaum-Helgoland, 1936, *Naturgeschichte und Wirtschaftliche Bedeutung der Seefische Nordeuropas* : 15.

The following account is based upon 132 adults in the collection of the Scottish Home Department's Laboratory at Torrey, Aberdeen, obtained mainly from the coastal waters of north and west Scotland and Northern Ireland, and three late vexillifers in the collection of the British Museum (Natural History), obtained at Banff. The type was found dead on a beach at Glenarm, Co. Antrim, Northern Ireland. It can no longer be traced.

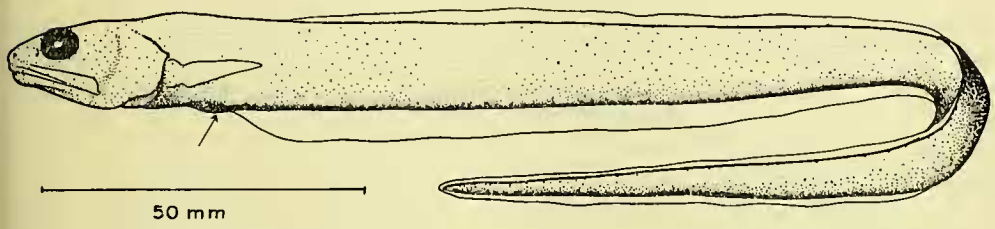

FIG. 16.—*Echiodon drummondi* Thompson. A representative specimen from Scottish waters.

SPECIFIC CHARACTERS. Greatest recorded length 300 mm.; length of head one-ninth to one-eleventh of total length ; maximum depth of head about one-half and maximum width about one-third of length of head ; upper profile of head convex ; horizontal diameter of eye slightly greater than length of snout, about twice as great as interorbital width ; maxilla extends well behind posterior edge of orbit ; anus 3–5 mm. posterior to roots of pectoral fins ; pectorals about three-fifths length of head ; patch of teeth on vomer rounded anteriorly, tapering posteriorly and merging with bands of palatine teeth ; colour in life believed to be reddish, with silvery abdomen, operculum and iris and dark markings on top of head, along edges of median fins and on tip of tail. (Silvery regions and dark markings are usually visible in preserved specimens.)

There is a vexillifer larva, resembling adult in form of lower jaw and in dentition. It is translucent in life, with reddish colour along dorsal and ventral surfaces, silvery spot near anus, dark-green pupil and silvery iris (Edward, private communication, cited by Couch, 1864). Eggs and other stages in the life history are unknown.

Measurements and proportions of representative adults are given in Table XIV, and a summary for the specimens examined in Table XV.

TABLE XIV.—Echiodon drummondi *Thompson. Measurements and Proportions of Representative Adults.*

Locality.	61° 01′ N., 00° 30′ W. in 155 m.		Adriatic.	
	mm.		mm.	
Total length	215		250	200
Length of head	24	(11% TL)	25 (10% TL)	22·5 (11% TL)
Maximum depth of head	10	(42% HL)	12 (48% HL)	10 (44% HL)
Maximum width of head	8	(33% HL)	9 (36% HL)	7 (31% HL)
Length of snout	4	(15% HL)	6 (24% HL)	4·5 (20% HL)
Horizontal diameter of eye	5	(21% HL)	6 (24% HL)	5 (22% HL)
Vertical diameter of eye	4	(17% HL)	4·5 (18% HL)	4 (18% HL)
Interorbital width	2·5	(10% HL)	4 (16% HL)	4 (18% HL)
Length of maxilla	10·5	(44% HL)	13 (52% HL)	11·5 (51% HL)
Length of pectoral fin	14	(58% HL)	15 (60% HL)	13 (58% HL)
Maximum depth of body	10	(42% HL)	12 (48% HL)	10 (44% HL)
Preanal length	26	(12% TL)	32 (13% TL)	24 (12% TL)

TL = total length ; HL = length of head.

TABLE XV.—Echiodon drummondi *Thompson. Summary of Measurements and Proportions of Adults.*

Variate.	N.	R. mm.	$M \pm \sigma_M$. mm.
Total length	104	160–292	257·1±2·59
Length of head	114	15–30	25·4±0·26
Depth of head	114	8·15	12·1±0·14
Width of head	108	6·13	9·7±0·14
Pectoral length	114	10–20	15·0±0·19
Preanal length	112	20–38	30·7±0·34
		%	%
Length of head (% TL)	104	9·09–11·73	10·31±0·05
Depth of head (% HL)	114	40·00–56·00	47·48±0·28
Width of head (% HL)	108	23·26–46·43	38·14±0·36
Pectoral length (% HL)	114	41·27–46·43	58·89±0·56
Preanal length (% TL)	102	11·11–14·80	12·48±0·04

N = number of specimens ; R = range of variate ; M = mean of variate (± standard error of mean, σ_M) ; TL = total length ; HL = length of head.

Echiodon drummondi is apparently not uncommon in the coastal waters round the north and west coasts of the British Isles and has been taken at a considerable number of localities at depths down to 100 fathoms (200 metres). It has also been reported from Scandinavian waters. A specimen from the Oceanographic Institute at Split is also assigned to *E. drummondi*, though it may ultimately prove to be subspecifically distinct. The measurements of this specimen are given in Table XIV.

Cuvier described two fierasfers from the Mediterranean of which one, *Ophidium*

imberbe, is that now termed *Carapus acus*. The other, *Ophidium dentatum* Cuvier, 1817, was said to differ from the first and more common species only by the presence of " deux dents en crochets ", a character which barely constitutes a recognizable description. Kaup (1856*a*) examined a number of specimens of *O. dentatum*, at that time preserved in the Paris Museum, and concluded that Cuvier's Mediterranean and Thompson's Atlantic fierasfer were identical. Both have therefore been recorded by later authors as *Fierasfer dentatus*, the name used by Kaup.

Though *C. acus* is fairly common in the Mediterranean, the other fierasfer is extremely rare and known from only a few localities. I have been able to examine only two, one from Monaco and another, very poorly preserved, from Sicily. The Atlantic fierasfer is also generally regarded as extremely rare and has even been

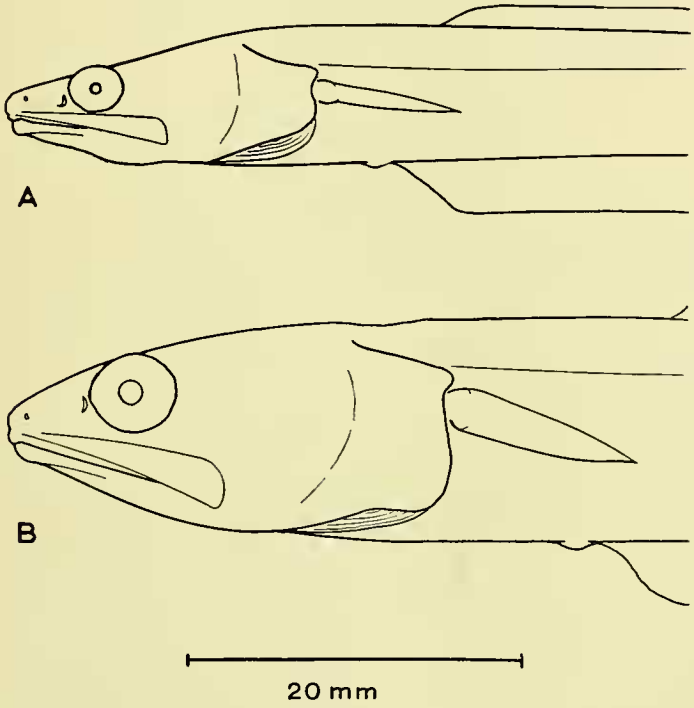

FIG. 17.—Heads of *Echiodon* spp. A, *E. dentatus* ; B, *E. drummondi*.

mentioned by some authors as an exotic stray from the Mediterranean ; but during the past fifty years (excluding the war periods) the research vessels of the Aberdeen Laboratory have obtained well over 100 adult fish which accord well with the description given by Thompson.

It is almost certain that Cuvier's types, assuming they were indeed the specimens seen by Kaup, are no longer in existence ; certainly they are not in the Paris collection. Thompson's specimen has also disappeared. It is therefore impossible to determine the status of these two forms by comparison of types, but from examination of the specimens preserved at Aberdeen and Monaco conforming to the description of *E. drummondi* and *O. dentatum* respectively it is clear that they are in fact two different species. They closely resemble each other in the structure of the lower jaw and of the first three vertebrae, in the presence of fang-like teeth at the front of both jaws and in the posterior position of the anus. However, they differ greatly in their dimensions and to a certain extent in their proportions. Other differences are apparent in the shape of the head, the obliquity of the mouth and the form of the operculum (Text-fig. 17). A further difference lies in the shape of the vomer, as displayed by the teeth it bears. In the Atlantic form the vomer tapers posteriorly, and there is no gap between vomerine and palatine teeth ; in the Mediterranean species the vomer terminates abruptly and its teeth are separated from those of the palatines by a well-marked gap.

Echiodon dentatus (Cuvier), 1817

(Text-fig. 18)

Ophidium dentatum Cuvier, 1817, *Règne Animal*, **2** : 239.

Fierasfer dentatus, Kaup, 1856, *Verh. phys.-med. Ges. Wurzburg.* **7** : 233. Kaup, 1856, *Arch. Naturges*, **22** : 93. Giglioli, 1880, *Esposizione di Pesca* : 97. Emery, 1880, *Fauna u. Flora Neapel*, **2** : 17. Carus, 1885, *Prodromus Faunae Mediterranea*, **2** : 580. Raffaele, 1888, *Mitt. zool. Stat. Neapel*, **8** : 1. Moreau, 1891, *Histoire Naturelle des Poissons de la France, Supplément* : 59. Belotti, 1891, *Atti Soc. ital. Sci. nat. Milano*, **33** : 127. Moreau, 1892, *Manuel d'Ichthyologie Française* : 405.

The following account is based upon one specimen in the collection of the Institut Océanographique, Monaco ; locality, Monaco : and another in the collection of the Universitetets Zoologiske Museum, Copenhagen ; locality Sicily.

Cuvier stated that his fish came from the Mediterranean. He did not designate a type and it is not certain that his specimens were preserved. The specimens examined by Kaup came, he believed, from Naples, but seem to be no longer in existence.

Specific characters. Total length 170 mm.; length of head one-ninth of total length ; upper profile of head straight ; maximum depth of head two-fifths, and maximum width one-third, of length of head ; horizontal diameter of eye slightly less than length of snout, nearly twice as great as interorbital width ; anus 4 mm. posterior to roots of pectorals ; pectoral fins slightly less than one-half length of head ; maxilla extends behind eye for distance equal to horizontal diameter of eye ; vomer rounded posteriorly ; vomerine and palatine teeth separated by a distinct gap ; colour in life unknown. Eggs attributable to this species have been described (Raffaele, 1888).

Measurements of this specimen are given in Table XVI. *Echiodon dentatus* has been recorded from Nice, Monaco, Naples, Sicily and the Adriatic.

FIG. 18.—*Echiodon dentatus* (Cuvier). A specimen from Monaco.

TABLE XVI.—Echiodon dentatus (*Cuvier*). *Measurements and Proportions of a Specimen in the Collection of the Institut Océanographique de Monaco.*

	mm.	
Total length	170	
Length of head	19	(11% TL)
Maximum depth of head	8	(42% HL)
Maximum width of head	6	(32% HL)
Length of snout	3·5	(18% HL)
Horizontal diameter of eye	3·2	(17% HL)
Vertical diameter of eye	2·5	(14% HL)
Interorbital width	2	(11% HL)
Length of maxilla	10	(53% HL)
Length of pectoral fin	9	(47% HL)
Maximum depth of body	9	(47% HL)
Preanal length	23	(14% TL)

TL = total length ; HL = length of head.

SPECIES POSSIBLY ATTRIBUTABLE TO *ECHIODON*

Carapus rendahli Whitley, 1941

Fierasfer sp., Rendahl, 1925, *Vidensk. Medd. Dansk. Nat. Foren.* **81** : 13.
Carapus rendahli Whitley, 1941, *Austral. Zool.* **10** : 40.

The type, the only specimen known, was obtained at Port Jackson, New South Wales, and is now in the Australian Museum, no. I.2, 411. It has not been available for study and the following account is compiled from Whitley (1941).

SPECIFIC CHARACTERS. Total length 93 mm.; length of head less than one-eighth of total length ; maximum depth of head a little less than one-half and maximum width one-quarter of length of head ; horizontal diameter of eye as great again as length of snout, three times interorbital width ; maxilla extends a short distance behind orbit ; anus about 3 mm. posterior to roots of pectorals ; pectoral fins one-quarter length of head ; colour in life unknown. A number of vexillifers from New South Wales waters were provisionally attributed to this species.

The specimen is small and so may not be fully adult. The tip of the tail is broken off and a portion of the intestine protrudes through the anus. The general appearance as figured by Whitley is not that of a *Carapus*, but of a fish closely resembling *Echiodon drummondi*. The correspondence with *Echiodon* is shown also by the presence of fang-like teeth at the front of the jaws and by the posterior position of the anus, but cannot be proved without reference to the vertebral and jaw structure, neither of which have been described. It is not clear from the figure whether this specimen has a diastema in the lower jaw. Two further points suggesting that *C. rendahli* may in fact be an *Echiodon* are provided by the broken tail and intestinal prolapse. Damage to the tail is frequent in *Echiodon* and nearly 10% of the *E. drummondi* in the Aberdeen collection have broken or regenerating tails. On the other hand, *Carapus* spp. have seldom been found with broken tails, never with the tail stump showing signs of regeneration. Prolapse is also frequent in preserved *Echiodon drummondi*, unknown in *Carapus* spp. These two characters are not, of course, diagnostic, but are extremely suggestive.

Carapus cinereus Smith, 1955

Carapus cinereus Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (12) **8** : 409.

The type, the only specimen known, was taken in a tide pool at Inhaca Island (26° S., 33° D.) and is preserved in the Department of Ichthyology, Rhodes University, Grahamstown, South Africa. It has not been available for study and the following account is derived entirely from the original publication.

SPECIFIC CHARACTERS. Total length 215 mm.; length of head less than one-ninth of total length ; maximum width of head two-fifths, maximum depth about one-half of length of head ; diameter of eye less than length of snout, greater than interorbital width ; maxilla extends behind eye for distance equal to about one-half diameter of orbit ; teeth of jaws small, blunt, conical, arranged in bands which terminate well before symphysis ; large, curved teeth at front of both upper and lower jaws, from description apparently separated by a diastema from other teeth ; vomerine teeth conical, of several sizes ; palatine teeth conical, generally small ; pectoral fins about one-half length of head ; anus clearly posterior to base of pectorals ; translucent in life with pink sheen, abdomen silvery, top of head dusky.

Apart from the total length the measurements of this specimen have not been published, but proportions are listed in the original paper.

The extreme length, relatively short head and cylindrical body of this specimen are characters which, though shown to a certain extent by *C. parvipinnis*, are by no means typical of the genus *Carapus*. The nature of the lower jaw and dentition are sufficient to exclude this species from *Encheliophis*, and its general appearance and the presumed presence of a diastema between the large anterior teeth and small posterior teeth in both jaws suggest that in fact this species should be assigned to *Echiodon*. The posterior position of the anus, the shape of the head, flatness of the interorbital and impingement of the upper edge of the orbit upon the dorsal profile of the head are further characters in which this form differs from veritable *Carapus* spp. and resembles *E. drummondi*.

Genus ***ENCHELIOPHIS*** Müller, 1842

Type species ***Encheliophis vermicularis*** Müller, 1842

Encheliophis Müller, 1842, *Ber. Verh. Preuss. Akad.* **1842** : 205. Type species *Encheliophis vermicularis* Müller, 1842.

Jordanicus Gilbert, 1905, *Bull. U.S. Fish. Comm.* **23** : 655. Type species *Fierasfer umbratilis* Jordan & Evermann, 1902, *Bull. U.S. Fish. Comm.* **22** : 206.

Encheliophiops Reid, 1940, *Rep. Allan Hancock Pacific Exp.* **9** : 47. Type species *Encheliophiops hancocki* Reid, 1940.

GENERIC CHARACTERS. Body elongated, cylindrical ; lateral processes of first and second vertebrae long, not expanded ; of third, fourth and fifth vertebrae long, expanded and fused into broad plates ; of sixth and subsequent vertebrae short, not expanded ; trunk vertebrae 30–31 ; lower jaw slender, curved, tapering to tip ; teeth in single rows on jaws and palatines even in adult ; no diastema ; no fleshy lip to lower jaw ; maxilla concealed beneath skin ; interorbital domed, raising upper

profile of skull considerably above orbit ; pectorals small or absent, but pectoral girdle always present ; anus beneath roots of pectoral in adult ; branchiostegals 6 or 7.

This genus was created to contain a finless fierasfer, *Encheliophis vermicularis*, from the Philippines. Subsequently other finless forms have been described from localities off the Pacific coast of Central America. One of these species, *E. hancocki*, introduced a new generic name *Encheliophiops*. This genus was separated from *Encheliophis* solely on the grounds that the only specimen known had the tip of the tail finless. This character, however, is shown by certain of the tenuis larvae of *Carapus acus* and by itself cannot be regarded as adequate for generic separation. *Encheliophiops* is accordingly regarded as synonymous with *Encheliophis*.

Also included with *Encheliophis* in the present work are the species customarily assigned to the genus *Jordanicus*. This genus was created to contain the single species *Fierasfer umbratilis* (generally accepted as a synonym for *Oxybeles gracilis*) and was stated to differ from other genera in the uniserial dentition, concealed maxilla and absence of a lip in the upper jaw. Radiographs of the type and other specimens of *Oxybeles gracilis* have added the structure of the lower jaw and fusion between the 3rd, 4th and 5th vertebrae to the original characters. In all these features the species assigned to *Jordanicus* differ from all other fierasfers except species of *Encheliophis*. The only difference which it has been possible to detect between *Encheliophis* and *Jordanicus* is the absence in the former of pectoral fins. However, the pectoral fins of *Jordanicus* are relatively far smaller than those of *Carapus* spp. and obvious though the presence of pectoral fins is as a diagnostic character, it is considered that this difference, unsupported by other characters, is insufficient to warrant generic distinction. The two genera are accordingly united, *Encheliophis* Müller, 1842, taking precedence over *Jordanicus* Gilbert, 1905. *Jordanicus* is retained, however, as a subgenus under *Encheliophis*.

Subgenus *ENCHELIOPHIS*

SUBGENERIC CHARACTERS. Pectoral fins absent ; branchiostegals 6.

KEY TO SPECIES

1.	Membranes of dorsal and anal fins continuous round tip of tail	2
	Membranes of dorsal and anal fins not continuous round tip of tail . .	*E. hancocki*
2.	Body darkly pigmented	*E. vermicularis*
	Body not darkly pigmented	*E. jordani*

Encheliophis vermicularis Müller, 1842

(Text-fig. 19)

Encheliophis vermicularis Müller, 1842, *Ber. Verh. preuss. Akad. Wiss.* **1842** : 205. Müller, 1843 *Abhandl. Akad. Wiss. Berlin*, **1843** : 109. Kaup, 1856, *Catalogue of Apodal Fish* : 157. Günther, 1862, *Catalogue of Fishes*, **4** : 381. Herre, 1936, *Publ. Field Mus. zool. Ser.* **21** : 417. Abe, 1939, *Palao trop. biol. Stud.* **1** : 574. Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (2) **8** : 416.

Enchelyophis vermicularis Müller, 1843, *Arch. Naturges.* **9** : 329.

The study material includes a single specimen in the collection of the Universitetets Zoologiske Museum, Copenhagen, from Sambelong, mouth of the Ganges; and two in the British Museum (Natural History) obtained off Lizard Island, Great Barrier Reef, and at Tahiti. The type was obtained in the Philippines. It is uncertain whether it is still in existence.

SPECIFIC CHARACTERS. The following description is of the specimen obtained at Sambelong by the *Galathea* expedition and placed in the Universitetets Zoologiske Museum.

Total length 79 mm. (greatest recorded for this species 175 mm.); head one-eleventh of total length; maximum depth of head two-fifths and maximum width rather less than one-third of length of head; horizontal diameter of eye slightly

FIG. 19.—*Encheliophis vermicularis* Müller. A specimen from Sambelong, India.

less than length of snout, slightly more than interorbital width; maxilla extends behind orbit for a distance equal to half horizontal diameter of eye; preanal length equals length of head; dark brown in life (Müller, 1842). Life history unknown.

Measurements of this and another specimen are given in Table XVII.

TABLE XVII.—Encheliophis vermicularis *Müller. Measurements and Proportions.*

Collection	Danish Museum.	British Museum.
Number	—	1933.8.12.47.
Locality	Sambelong.	Lizard Is.
	mm.	mm.
Total length	79	134
Length of head	7 (9% TL)	11·5 (9% TL)
Maximum depth of head	3 (43% HL)	5·5 (48% HL)
Maximum width of head	2 (29% HL)	4 (35% HL)
Length of snout	1·3 (19% HL)	2 (17% HL)
Horizontal diameter of eye	1·1 (16% HL)	2 (17% HL)
Vertical diameter of eye	1 (14% HL)	1·7 (17% HL)
Length of maxilla	3 (43% HL)	6 (52% HL)
Interorbital width	1 (14% HL)	2 (17% HL)
Maximum depth of body	3·5 (50% HL)	6 (72% HL)
Preanal length	7 (9% TL)	12 (9% TL)

TL = total length; HL = length of head.

E. vermicularis has been recorded from the coasts of Somaliland and India, the Philippines, Palao, Sulu Sea and Tahiti. It was taken in holothurians in the Philippines and is said to feed upon the viscera of its host (Semper, 1861).

Encheliophis jordani Heller & Snodgrass, 1903

Encheliophis jordani Heller & Snodgrass, 1903, *Proc. Acad. Sci. Washington*, **5** : 220.

The type, the only specimen known, was obtained at Tagus Cove, Albermarle Island, during the Hopkins Stanford Galapagos Expedition and deposited in Leland Stanford Junior University Museum, catalogue no. 6345. It has not been available for study and the following account is based upon the original description.

SPECIFIC CHARACTERS. Total length 114 mm.; length of head one-eleventh of total length ; maximum depth of head one-half its length, maximum width not stated ; horizontal diameter of eye less than snout length, slightly more than interorbital width ; maxilla extending short distance behind orbit ; small, rounded, patch of teeth on vomer ; anus below posterior border of operculum ; head and body dusky pink in life, abdomen silver, tail greyish-lavender, iris greenish-grey ; colours fading on preservation. Life history unknown.

Encheliophis hancocki (Reid), 1940

Encheliophiops hancocki Reid, 1940, Rep. *Allan Hancock Pacific Exp.* **9** : 47. Steinbeck & Ricketts, 1941, *Sea of Cortez :* 575.

The type was taken among the coral *Pocillipora* sp. at Gorgona Island, Columbia, during the course of the Hancock Pacific Expedition, 1935, and placed in the United States National Museum, catalogue no. 101789. It has not been available for study.

SPECIFIC CHARACTERS. Total length of type 74·8 mm.; length of head one-eleventh of total length ; maximum depth one-half and maximum width two-fifth of length of head ; horizontal diameter of eye equal to length of snout, slightly greater than interorbital width ; maxilla extends slightly behind orbit ; vomerine teeth not described ; anus about 2 mm. behind hind border of operculum ; median fins not continuous round tip of tail, which ends in a bare point : colour in life unknown. Life history unknown.

A second specimen was obtained from the cloaca of *Holothuria lubrica* taken in the Gulf of California (Steinbeck & Ricketts, 1941).

The status of the species of *Encheliophis* is doubtful and it is not entirely clear to which the various recorded specimens ought to be assigned. Certainly there is one fierasfer, *Encheliophis vermicularis*, which lacks paired fins, but though the majority of specimens noted by other authors have been ascribed to this species, they have not been figured, nor have their measurements been recorded. In consequence it has not been possible to build up a body of data giving some picture of the species as a whole, as has been the case with other members of the Carapidae.

The species of *Encheliophis* do not, so far as is at present known, differ greatly in proportions or in dentition and separation is based mainly upon colour. This is not a good criterion, but is the best available. Certainly, the dark pigmentation of *E. vermicularis*, which persists on preservation, makes it easy to distinguish this species from the paler *E. jordani*. *E. jordani* and *E. hancocki* resemble each other very closely indeed, and may ultimately prove to be conspecific.

Subgenus *JORDANICUS*

SUBGENERIC CHARACTERS. Pectoral fins present, small; branchiostegals 7.

KEY TO SPECIES (ADULTS ONLY)

Vomerine teeth in single short median row . . . . . *E. (Jordanicus) gracilis*
Vomerine teeth in short band of about four rows . . . *E. (Jordanicus) sagamianus*

Encheliophis (Jordanicus) gracilis (Bleeker), 1856

(Text-fig. 20)

Oxybeles gracilis Bleeker, 1856, *Nat. Tijdschr. Ned.-Ind.* **11** : 105. Doleschall, 1858, *Nat. Tijdschr. Ned.-Ind.* **15** : 163.
Fierasfer gracilis, Günther, 1862, *Catalogue of Fishes*, **4** : 381. Pietschmann, 1938, *Bull. Bishop Mus.* **156** : 51. Tortonese, 1939, *Boll. Mus. zool. Anat. comp. Torino*, **47** : 379.
Fierasfer punctatus Fischer, 1885, *Jahrb. Hamburg Wiss. Anst.* **2** : 74. Barnard, 1927, *Ann. S. Afr. Mus.* **21** : 884.
Fierasfer umbratilis Jordan & Evermann, 1902, *Bull. U.S. Fish. Comm.* **22** : 206. Jordan & Evermann, 1903, *Bull. U.S. Fish. Comm.* **23** : 505.
Jordanicus umbratilis Gilbert, 1905, *Bull. U.S. Fish. Comm.* **23** : 655.
Fierasfer frantii Popta, 1912, *Notes Leyden Mus.* **23** : 185.
Carapus gracilis, Fowler, 1925, *Proc. Acad. nat. Sci. Philadelphia*, **77** : 283. Fowler, 1926, *Ann. Natal Mus.* **5** : 402. de Beaufort & Chapman, 1951, *Fishes of the Indo-Australian Archipelago*, **9** : 449.

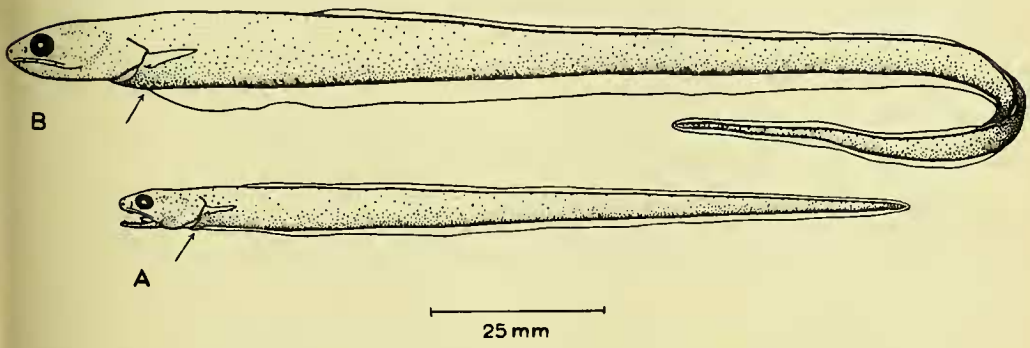

FIG. 20.—*Encheliophis (Jordanicus) gracilis* (Bleeker).
A, The type; B, a more fully adult specimen.

Fierasfer (Jordanicus) gracilis, Barnard, 1927, *Ann. S. Afr. Mus.* **21** : 884.
Jordanicus gracilis, Fowler, 1928, *Mem. Bishop Mus.* **10** : 447. Fowler, 1931, *Mem. Bishop Mus.* **11** : 364. Fowler, 1934, *Mem. Bishop Mus.* **11** : 447. Abe, 1939, *Palao trop. biol. Stud.* **1** : 575. Schultz, 1943, *Bull. U.S. nat. Mus.* **180** : 287. Smith (J. L. B.), 1949, *Sea Fishes of Southern Africa* : 359. Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (12) 8 : 404.
Carapus puntatus, Smith (J. L. B.), 1949, *Sea Fishes of Southern Africa* : 359.
Jordanicus punctatus, Smith (J. L. B.), 1955, *Ann. Mag. nat. Hist.* (12) 8 : 405.

Study material includes the type and nine other adults in the collection of the British Museum (Natural History); localities represented are Samoa, Pelew Islands,

Tahiti. Varaii, Ovalau, Savaii and Wallis Island ; also one adult in the collection of the Universitetets Zoologiske Museum, Copenhagen, from Ghardaqa, Red Sea.

The type was obtained at Banda Island, Indonesia, and is now in the collection of the British Museum (Natural History) under catalogue no. 1861.2.28.51.

SPECIFIC CHARACTERS. Greatest recorded length 236 mm.; length of head one-eighth to one-tenth or less of total length ; maximum depth of head about two-fifths of total length, maximum width slightly less ; horizontal diameter of eye equal to length of snout, slightly greater than interorbital width ; mouth almost horizontal ; jaw teeth well-separated from each other ; posterior part of lower jaw toothless in some specimens ; vomerine teeth one to four, in single median row, conical and of moderate size ; pectoral fins one-third length of head.

The colour of the living animal has been described upon four occasions, but the accounts are conflicting. Jordan and Evermann (1902) described a fish taken at Hilo as pale olivaceous with greenish spots. The colour pattern is given with meticulous detail, not only for the body, but also for the first and second dorsal, anal, caudal, pectoral and pelvic fins. Obviously, these notes do not refer to a fierasfer at all. The next description (Fowler, 1925) is of a specimen from the Natal Coast, recorded as " ecru-drab with darker mottlings", while in a subsequent paper (Fowler, 1926) the same specimen was described as pale mauve with a blue tinge. Smith (1955) described a specimen from Aldabra as translucent with a yellowish sheen and dark markings. The eggs and young stages of this species are unknown.

Measurements and proportions of representative adults are given in Table XVIII, and a summary for the specimens examined in Table XIX.

TABLE XVIII.—Encheliophis (Jordanicus) gracilis (*Bleeker*).
Measurements and Proportions of Adult Specimens.

Collection	British Museum.		Danish Museum.			
Number	1861.11.28.51.		1875.10.5.56.		—	
Locality	Banda.		Samoa.		Ghardaqa.	
	mm.		mm.		mm.	
Total length	116*		223		153	
Length of head	12·5	(11% TL)	23	(10% TL)	15	(10% TL)
Maximum depth of head	5·5	(44% HL)	10	(43% HL)	6	(40% HL)
Maximum width of head	5	(40% HL)	9	(39% HL)	5	(33% HL)
Length of snout	2·5	(20% HL)	4	(17% HL)	3	(20% HL)
Horizontal diameter of eye	2·5	(20% HL)	4	(17% HL)	3	(20% HL)
Vertical diameter of eye	2	(16% HL)	3·5	(15% HL)	2·5	(17% HL)
Interorbital width	2·5	(20% HL)	4	(17% HL)	3·5	(23% HL)
Length of maxilla	7	(56% HL)	10·5	(46% HL)	8	(53% HL)
Length of pectoral fin	4	(32% HL)	9	(39% HL)	5	(33% HL)
Maximum depth of body	6	(48% HL)	11	(48% HL)	9	(60% HL)
Preanal length	12	(10% TL)	21	(9% TL)	14	(9% TL)

* Type specimen.
TL = total length ; HL = length of head.

TABLE XIX.—Encheliophis (Jordanicus) gracilis (*Bleeker*). *Summary of Principal Measurements and Proportions of Adults Examined.*

Variate.	N.	R. mm.	M. mm.
Total length	11	116–223	178·2
Length of head	11	12·5–23	18·5
Depth of head	11	5·5–10	7·9
Width of head	10	5–9	6·9
Pectoral length	11	4–9	6·5
Preanal length	8	12–21	18·3
		%	%
Length of head (% TL)	11	9·6–11·8	10·4
Depth of head (% HL)	11	37·5–47·6	42·5
Width of head (% HL)	10	31·3–42·9	37·7
Pectoral length (% HL)	11	31·3–40·0	34·7
Preanal length (% TL)	8	9·1–11·8	9·8

N = number of specimens; R = range of variate; M = mean value of variate; TL = total length; HL = length of head.

This species occurs in the Pacific and Indian Oceans and has been recorded from Celebes, Indonesia, New Guinea, Cocos Islands, Pelew Islands, Fiji, Samoa, Tonga, Hawaii, Solomon Islands, Mozambique, Natal and Aldabra. The Pacific Ocean specimens have been found mainly in the starfish *Culcita discoidea*, while the specimen taken at Mozambique was in *Holothuria scabra*.

Fierasfer umbratilis has long been accepted as a synonym of *E. gracilis* and *F. frantii* has recently also been attributed to this species (de Beaufort & Chapman, 1951), since there is nothing in the very careful description to enable the two to be separated. The species long ago recorded from Mozambique as *F. punctatus* must belong to *Encheliophis* for its large size shows that it was adult, yet the teeth of jaws and palatines were in single rows only. A fierasfer in the Danish collection, obtained at Ghardaqa, Red Sea, is clearly referable to *F. neglectus* yet does not differ sufficiently from the available specimens of *E. gracilis* to be regarded as specifically distinct.

Encheliophis (Jordanicus) sagamianus (Tanaka), 1908

Carapus sagamianus Tanaka, 1908, *Annot. zool. jap.* **7** : 40. Tanaka, 1911, *Figures and Descriptions of the Fishes of Japan* : 25. Tanaka, 1927, in *Figuraro de Japanaj Bestoj*. Yosii, 1928. *Annot. zool. jap.* **11** : 339.
Carapus sagamius, Franz, 1910, *Abhandl. Bayer. Akad. Wiss. Suppl.* **4** : 31.
Jordanicus sagamianus, Matsubara, 1953, *Jap. J. Ichthyol.* **3** : 30.

The type was found in a holothurian taken in Sagami Bay, Japan, and placed in the Zoological Museum of the Imperial Science College, Tokyo, no. 1751. No specimens have been available for study and the following description is based upon those published by Tanaka.

SPECIFIC CHARACTERS. Greatest recorded length 190 mm.; length of head one-tenth of total length; depth of head slightly greater than width; horizontal diameter of eye equal to length of snout and to interorbital width; mouth nearly

horizontal; maxilla extends only to posterior edge of orbit; vomerine teeth in narrow band of four rows; pectoral fins one-third length of head; colour in life unknown.

E. sagamianus has been recorded only from Japan, at Sagami, Boshuu, Urugu and Misaki. It has been taken in the intestine of *Holothuria monacaria* and once in the starfish *Nardoa semiregularis* var. *japonica*.

Smith (1955) includes this species in the synonomy of *Encheliophis gracilis*, but gives no reason why the two species should be united.

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